# St. Lucie County Sand Search – Geotechnical Investigations
# Reconnaissance Level Investigation

# Final Report

**Submitted to:**
**St. Lucie County**
**Erosion Control District**
**St. Lucie County, FL**
**In Association with FDEP**

**Submitted by:**

**Coastal Tech**
**Melbourne, FL**

**May 4, 2010**

COASTAL TECH
COASTAL TECHNOLOGY CORPORATION

## 1.0 Executive Summary

This document summarizes the results of a reconnaissance-level sand search investigation. In December 2008, Coastal Tech conducted an offshore reconnaissance-level sand search investigation including approximately 53 line miles of bathymetry and 16 twenty-foot vibracores from Pierce Shoal in state water, and from St. Lucie Shoal in federal water. Coastal Tech evaluated the bathymetry/vibracores and conferred with County and U.S. Army Corps of Engineers – Jacksonville District (USACE) staff regarding future quantities of sand needed for:

- future maintenance of the Ft. Pierce *Shore Protection Project,* which is currently expected to employ the previously-well-documented Capron Shoal as a sand source, and
- the *South County Beach Project* currently proposed for:
  - (a) initial construction by the County via use of sand from a previously-documented portion of the St. Lucie Shoal in state water, and
  - (b) maintenance by the USACE - currently under *Feasibility Phase* evaluation via use of potential borrow areas delineated herein.

Under separate authorization, Coastal Tech formulated measures to avoid and/or minimize borrow area impacts to pelagic fisheries associated with the shoals under consideration herein.

A *Plans & Specs Level Investigation Plan* is herein recommended to further characterize and quantify potential borrow areas suitable as a source of beach-compatible sand fill for the long-term nourishment of St. Lucie County beaches. The *Plan* is based upon:

- results of the reconnaissance-level offshore investigation,
- existing vibracores separately obtained,
  - (a) by the USACE for the Martin County *Shore Protection Project*,
  - (b) by the Florida Geological Survey and the Minerals Management Service (FGS & MMS) – as identified in a joint cooperative report entitled *A Geological Investigation of Sand Resources Along Florida's Central-East Coast* (Hoenstine et al, 2002), and
- appropriate measures to avoid and/or minimize impacts to pelagic fisheries via limited mining of shoals and undisturbed "refuge patches".

Reconnaissance-level vibracore data indicate that sand in the St. Lucie Shoal more closely matches the color of the native beach and is generally more beach-compatible as compared to sand in the Pierce Shoal. Coastal Tech recommends development of the St. Lucie Shoal as a potential borrow area to be further developed via the *Plans & Specs Level Investigation Plan*. As part of the reconnaissance-level investigation, Coastal Tech sought to delineate 25 million cubic yards of beach-compatible sand to:

- meet immediate and future needs for the 50 year life of the *South County Beach Project* – estimated at 1.6 to 4 million cubic yards of sand,
- serve as a backup to the Capron Shoal – for the Ft. Pierce *Shore Protection Project,* and
- potentially meet emergency needs of the County.

This target of 25 million cubic yards was established by multiplying the annual downdrift deficit caused by Ft. Pierce Inlet (estimated to be 130,000 cubic yards per year by Coastal Planning and Engineering in the 1996 Ft. Pierce Inlet Management Plan) by 50 years to get 6.5 million cubic yards. This amount was then doubled to 13 million cubic yards, as it is standard practice to seek

double the amount required when identifying borrow areas. Finally, this target amount was doubled again due to the potential of encountering poor quality sediment or environmental restraints. This number was rounded to an even 25 million cubic yard target.

Preliminary volume estimates developed from the reconnaissance-level vibracores indicate that St. Lucie Shoal may contain about 21.1 million cubic yards of sand – proposed to be verified and further developed through implementation of the *Plans & Specs Level Investigation Plan*.

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## 2.0 Task 2a – Offshore Borrow Area Investigation

### 2.1 Area of Investigations

In 2006, Coastal Planning & Engineering (CPE) conducted offshore geotechnical investigations to identify sand sources in association with the *South County Beach Project*. CPE identified five potential borrow areas in state waters, including four nearshore linear shoals and the landward portion of St. Lucie Shoal. This landward portion of the St. Lucie Shoal is proposed to be utilized for the proposed beach-fill project on South Hutchinson Island as described in the *St. Lucie County South County Beach Project - Design Document* (Coastal Tech, April, 2009).

St. Lucie County authorized Coastal Tech to conduct geotechnical investigations to identify additional beach-compatible sand sources for the long-term nourishment of St. Lucie County beaches. Coastal Tech herein examines the federal water portion of St. Lucie Shoal, as well as Pierce Shoal in state water. This document provides a summary of the reconnaissance-level investigation and provides the details of the recommended *Plans & Specs Level Investigation Plan.*

### 2.2 Bathymetric Survey

A bathymetric survey was performed by Morgan & Eklund, Inc. in August 2007. The survey was performed along transects spaced 1000 feet apart, perpendicular to the long axis of the shoals. About 53 line miles of bathymetric data were acquired during this survey. The survey instrumentation used included an Odom Hydrotrac single beam echosounder linked to a TSS 025 motion compensator.

The data were collected along each transect at a maximum data point spacing of 10 feet. All work activities and deliverables were conducted in accordance with the latest update of the Bureau of Beaches and Coastal Systems (BBCS) Statewide Coastal Monitoring Plan, Monitoring Plan Technical Specifications for Bathymetric Surveying (SCMP/RDCPP). The location and elevation of all data were collected and reported using the NAD83 horizontal datum and NAVD88 vertical datum.

### 2.3 Cultural Resources Survey

A cultural resources survey was performed by Southeastern Archaeological Research, Inc. (SEARCH) in June, 2008, for the purpose of identifying the presence or absence of submerged cultural resources within the proposed borrow areas; the survey was performed on behalf of the US Army Corps of Engineers in support of the St. Lucie County Shore Protection Project currently under formulation. Instrumentation used included a Klein Model 3000 Side Scan Sonar, Marine Magnetics Explorer magnetometer, and Syqwest, Inc. Stratabox™ Sub-Bottom Profiler, all integrated with a Trimble DSM-232 DGPS for sub-meter locational accuracy, as well as Hypack navigation software. Surveys were performed along transects spaced 100 feet apart, within the limits of the proposed borrow areas. All data were reported in State Plane (NAD83), Florida East, U.S.

Survey Feet. Results are outlined in the report entitled *Field Summary Report for the Historic Assessment and Submerged Cultural Resources Remote Sensing Survey of Four Borrow Areas for Martin and St. Lucie Counties Shore Protection Projects, Florida* (SEARCH, 2008). It is expected that the densely spaced nature of these surveys within all potential borrow areas should fulfill the need for cultural resource surveys for any proposed borrow areas.

## 2.4 Vibracoring

Sixteen vibracoring locations were chosen based on a review of the bathymetric data and previously obtained vibracores. Vibracores were obtained along the long axis of the shoals along the crest to ascertain the maximum thickness of the surficial sediment layers.

On December 4, 2008 a total of sixteen (16) vibracores were obtained from the long axis of Pierce shoal, in state water, and the St. Lucie Shoal in federal water, as illustrated in Figure 2.1. Vibracores were extracted by American Vibracore Services, Inc., under contract with Coastal Tech. Horizontal control for vibracore locations was maintained through the use of a Real-Time Differential GPS utilizing differential corrections from the Canaveral Continuously Operating Reference Station (C.O.R.S.). Morgan & Eklund, Inc., under contract with Coastal Tech, established top-of-core on December 6, 2008 through the use of a Coastal Instruments submersible tide gauge installed near the middle of the vibracore project area (leveled in from FDEP concrete monument 94-77-A06), in concert with a Real-Time DGPS, Hypack Navigation Software, and Odom CVM Digital Echosounder, and TSS Motion Compensator. The fathometer was calibrated at the start and conclusion of the survey day using a "bar check" to compensate for variations of the speed of sound in water, together with the calibration of the vessel for squat, settlement, and draft. While onboard, each vibracore was cut into 5 ft sections, labeled, and stored until the offshore survey was complete. The vibracores were then transferred to Coastal Tech's Coastal Geology and Sediments Laboratory located in Melbourne, Florida.

In addition, data were reviewed from a series of eighteen (18) existing vibracores previously obtained in association with the FGS/MMS cooperative study entitled *A Geological Investigation of Sand Resources Along Florida's Central-East Coast* (Hoenstine et al, 2002). These data included general vibracore logs, as well as granularmetric data from sediment samples. Top-of-core elevations were not included in the final FGS/MMS data set, so elevations were inferred from the bathymetry obtained during the current study; however, since there is some uncertainty associated with the vibracore elevations, cross sections were not prepared from these data.

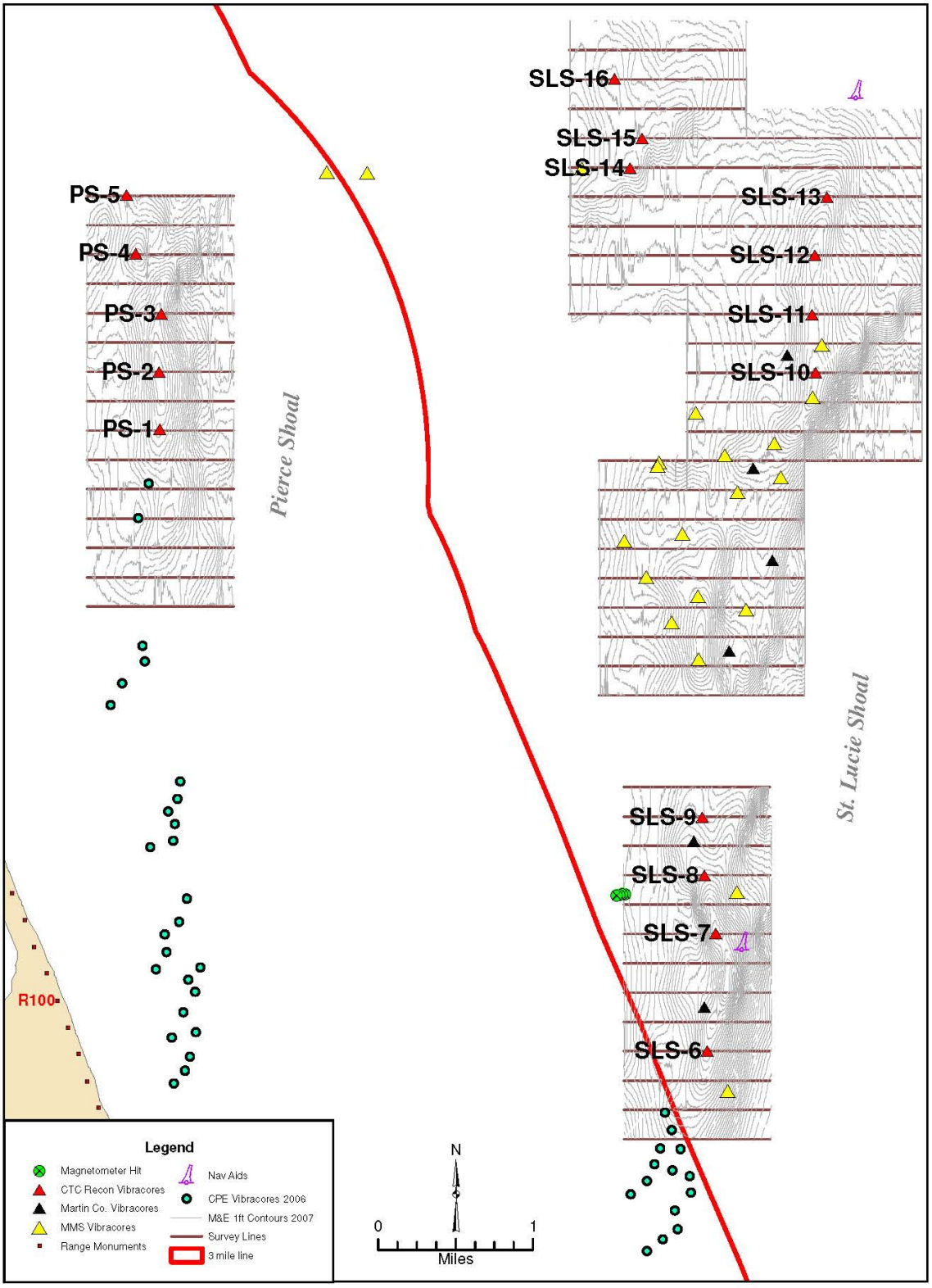


**Figure 2.1: Location Map - Reconnaissance & Existing Vibracores**

Data were also obtained from a series of six (6) existing vibracores, which were taken in association with the USACE/ Martin County Shore Protection Project (2006). These vibracores are "short due to poor recovery" (Garry Holem, pers. comm.), so they provide limited data.

## 3.0 Task 2b – Native Beach Field Investigation

The native beach on South Hutchinson Island was sampled by Coastal Tech in February 2007 to characterize the recent native beach sediments and assess compatibility with the potential borrow area material. Sixty native beach sediment samples were obtained from R77, R80, R85, R90, R95, R98, R100, R105, R110, and R115 as illustrated in Figure 3.1. Samples were obtained from the toe of dune, mid-berm, mean high water, mean low water and near the -3 foot contour. Samples were obtained from approximately 5" below the surface. Gradation analysis was performed using 20 sieves ranging from -4.25 phi to +4 phi at ½ phi intervals, including the -2.25 phi and +3.75 phi sieves. Compositional analyses through Loss on Ignition, as well as Munsell color analysis were performed. These data show that in 2007 the South Hutchinson Island consists of light gray to very pale brown, moderately to poorly sorted, medium grained sand with 50.5% carbonate, 1% organic, 2.2% gravel and <1% fines content. Laboratory results for native beach samples analyzed by COASTAL TECH are provided in this report as follows:

- Table 3.1
- Appendix 1a – Native sample sedimentology
- Appendix 1b – Native gINT sample gradation curves
- Appendix 1c – Native gINT sample granularmetrics

The above represents the *in-situ* beach material, at the indicated transects, during the time of sampling in 2007. Although it is referred to within this document as the "native beach", and care was taken to exclude any samples that may contain fill material that was placed prior to sampling, these data may not represent what would have been the true "native" beach if the region were in its natural state. The area has likely been significantly affected by anthropogenic factors, such as the artificial opening of Ft. Pierce Inlet directly north of the sampling area in the early 1900's. The significance of the inlet's impact on this beach is evidenced by the subsequent landward translation of the barrier island, during which the nearshore sediments were largely reworked, and long-buried material had become exposed.

In recognition of the ephemeral nature of the "native" beach over time, an effort was made to examine historical beach sediment characteristics in the area. The results of two historical sampling events were examined, both of which report on the native material in Martin County, on the southern extent of South Hutchinson Island. These data were reported in the *General Design Memorandum for the Martin County Shore Protection Project* (USACE, 1994). In 1965 the beach was sampled at 11 transects throughout Martin County from the "dry beach" to -18' (datum unknown). The composite mean grainsize for these data was reported to be 0.35mm with a sorting coefficient of 1.74.


**Figure 3.1: Location Map of Native Beach Sampling Locations**

| Sample | gINT Granularmetrics | | | | | | | USC | Composition (wt%) | | | Munsell Color Dry | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Size Class (wt%) | | | | Descriptive Statistics | | | | | | | | |
| | *Gravel* | *Sand* | *<#200* | *<#230* | *Mean (mm)* | *Verbal* | *Std. Dev.(phi)* | | *Organic* | *Carbonate* | *Siliciclastic* | *Verbal* | *Value* |
| Native Composite | 2.22 | 97.54 | 0.24 | 0.21 | 0.49 | M | 1.22 | SW | 1.1 | 50.5 | 48.4 | lt. gray | 10YR 7/2 |

**Table 3.1: Native Beach Sedimentology: 2007 Samples**

In 1990, ATM sampled 8 transects in Martin County north of St. Lucie Inlet from +10' to -20' NGVD. The composite mean grainsize for these data was reported to be 0.27mm with a sorting coefficient of 1.41.

Due to the large variance between the two historically reported native granularmetrics and the samples taken in association with the current study, all three sets of native data are considered when reporting *Overfill Factors*, and an *Overfill Factor* is given for each. However, composite grainsize distribution curves are only presented for the native beach samples obtained in association with the current study.

## 4.0 Task 2c – Vibracore Logs and Sediment Analysis

The sixteen 20 foot vibracores were obtained and transferred to Coastal Tech's Coastal Geology and Sediments Laboratory. Each vibracore was: (1) split along the long axis, (2) logged by visual observation using ENG Form 1836, and (3) photographed against an 18% gray background. Each vibracore was then encapsulated in a plastic sleeve. The archived vibracores will be stored at Coastal Tech's Coastal Geology and Sediments Laboratory (Melbourne, FL) for a period of 60 days following the final acceptance of this report by FDEP, after which time the vibracores will be transferred to the County or the Florida Geological Survey (Tallahassee, FL) when a permanent storage facility is designated.

A total of 84 sediment samples (i.e. approximately five samples per 20 ft. vibracore) were selected for analysis using standard FDEP laboratory methods to characterize: (1) texture, (2) composition, and (3) color. Sediment texture was quantified using nested sieves and described in accordance with the USC system. Composition was determined through Loss on Ignition, and color analysis was performed using the Munsell Book of Colors. Samples containing fines in excess of 12% passing through the #200 sieve were described on the basis of visual examination by a qualified coastal geologist.

Typically, only samples visibly containing silts, clays, or flocculated material are subjected to wet sieve analysis. However, during testing it became apparent that samples subjected to wet sieve analysis revealed a higher fine content than determined through conventional dry-sieve analysis - often to the point of non-compliance with FDEP standards per the FDEP "Sand Rule". In order to increase confidence in the percent fines in the upper level samples, all samples above the first non-compatible sample in St. Lucie Shoal were subjected to wet sieving regardless of dry sieve results or the absence of visible fines or sediment flocculation.

Laboratory results of vibracore and sediment sample analyses conducted by COASTAL TECH are provided in digital format (see enclosed CD containing gINT files) and within this report as follows:

- Table 5.1 – Vibracore Sedimentology
- Appendix 2a – Vibracore Sample Sedimentology
- Appendix 2b – Vibracore Photographs
- Appendix 2c – Vibracore gINT Core Logs
- Appendix 2d – Vibracore gINT Sample Gradation Curves
- Appendix 2e – Vibracore gINT Sample Granularmetrics
- Appendix 2f – American Vibracore Services 2008 Vibracoring Report
- Appendix 2g – CD-ROM Containing gINT files

In addition, the sedimentological records of the existing vibracores associated with the FGS/MMS project entitled *A Geologic Investigation of Sand Resources in the Offshore Area Along Florida's Central - East Coast* (Hoenstine et al, 2002) and the 2006 USACE Martin County Shore Protection Project are included in digital format and within the report as follows:

- Appendix 3a – FGS/MMS Vibracore Sample Sedimentology
- Appendix 3b – FGS/MMS DVD Report
- Appendix 4a – Martin County Vibracore Logs and Gradation Curves

## 5.0 Task 2d – Borrow Area Delineation and Compatibility Analysis

### 5.1 Methods

Potential borrow areas are herein delineated via identification of: reasonably continuous and significant (with cores reflecting >3 ft thick) layers of beach compatible sand as reflected in the core logs, geologic cross-sections, and sample analysis. The desirability and ranking of prospective borrow areas is prescribed by assessment of the color, the composite granularmetrics, and carbonate content associated with each prospective borrow area and the corresponding compatibility with the native beach as prescribed by the *Overfill Factor* determined per methods cited in the Coastal Engineering Manual (USACE, 2002).

## 5.2 Potential borrow area delineation

The offshore shoals included in this study comprise Pierce Shoal in state water, and St. Lucie Shoal in federal water. To delineate potential borrow areas:

- The boundaries of potential borrow areas are based on and surround the reconnaissance and/or prior vibracores, the topographic crest of the shoals, and the elevation of the recommended maximum depth of cut – established at two feet above the shallowest layer of non-compatible material within the vibracores.
- Grain-size distribution curves are compared for the sand from potential borrow areas with the native beach sand as sampled in 2007.
- Compatibility curves for the native beach and borrow area composite are compared to demonstrate the compatibility of potential borrow material.

At Pierce Shoal, five 20 foot vibracores were recovered, as depicted in Figure 5.1. Vibracores PS-1 through PS-5 penetrated a layer of gray to grayish brown moderately to poorly sorted carbonate sand of varying thickness, overlaying a layer of gray, moderately to poorly sorted silty, predominately carbonate sand. Figure 5.2 depicts a plan view of the potential borrow areas including Pierce Shoal (P-P'). The cross-section or post diagram is depicted in Figure 5.3, and an interpreted fence diagram is depicted in Figure 5.4. A legend is provided in Table 5.1. Vibracore PS-5 extends the deepest, and indicates that a silty matrix containing whole bivalve shells underlies the sandy portion of this shoal. For all vibracores obtained from Pierce Shoal (PS-1 to PS-5), with the exception of vibracore PS-3, sampling results indicate a layer of high gravel content (5% +) below the surficial layer but within the first five feet of the upper layers of sand, that exceeds the allowable 5% gravel content set forth by FDEP sand rule 62B41.007(2)(j). As a result, a shallow maximum depth of cut of -29.9' NAVD, above the excessive-gravel-layer, is herein assumed to calculate a borrow area composite for which samples were weighted vertically within the core, but all cores were weighted equally within the borrow area; the composite curve is compared against the 2007 native beach composite in Figure 5.5. This composite indicates that the potential borrow material in Pierce Shoal, is medium grained (0.49mm), poorly sorted skeletal sand with <1% fines and ~2% gravel content, and is composed of 79.7% carbonate. The volume of material available above this cut depth is approximately 1.3 million cubic yards. The *Overfill Factor* for this section based on these data is 1.07 for the native beach associated with the current study, 1.00 for the native beach from 1990 representing the Martin County portion of South Hutchinson Island, and 1.40 when compared to the native beach calculated from the 1965 data representing the entirety of Martin County. The limited volume, due to the gravel portion, coupled with the darker color of this shoal indicates that the material within Pierce Shoal is less beach-compatible than the St. Lucie Shoal as investigated in this study. As a result, Coastal Tech does not propose further development of Pierce Shoal during the plans and specs level investigation.

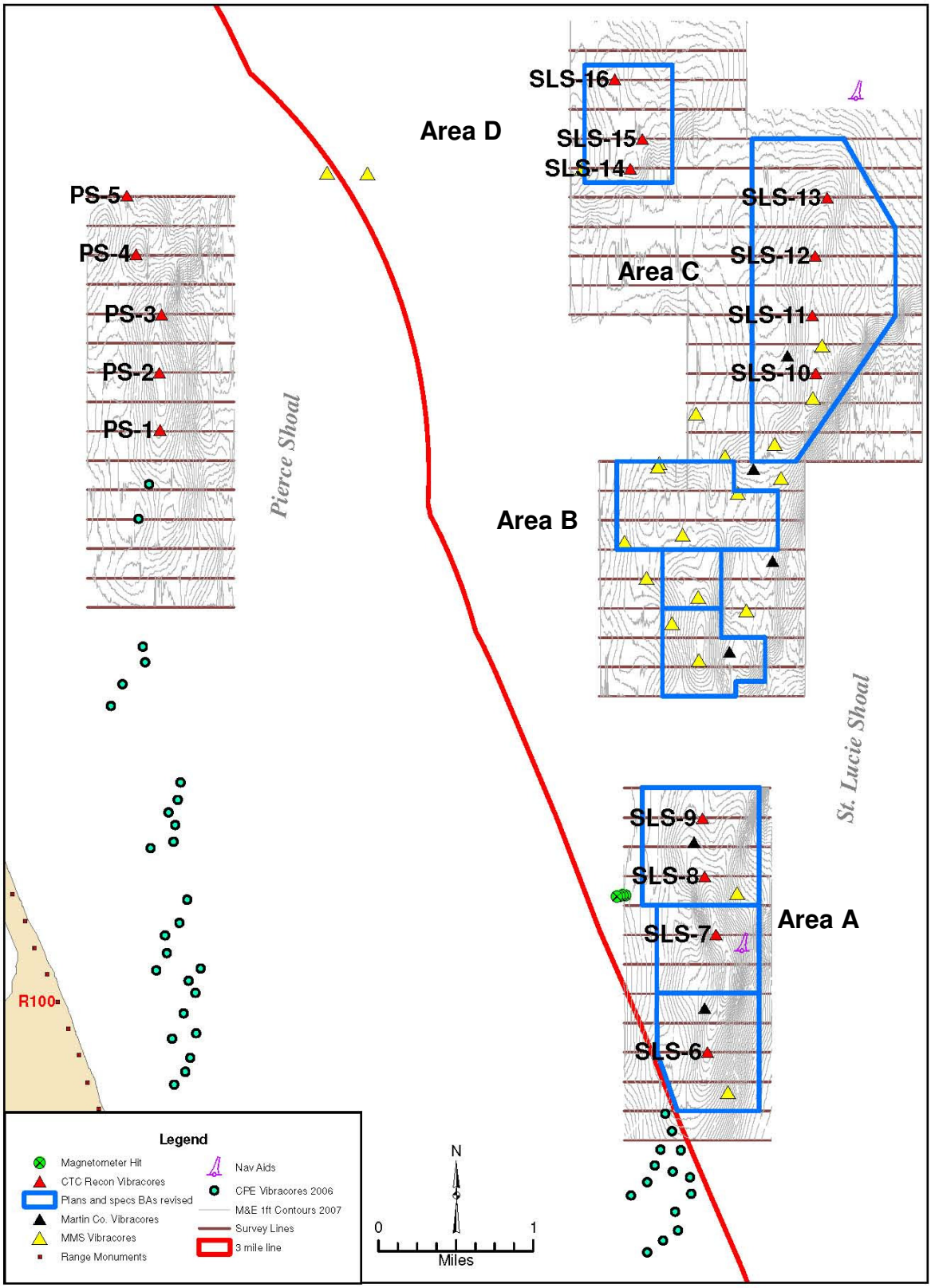


**Figure 5.1: Vibracore Locations and Potential Borrow Area Boundaries**

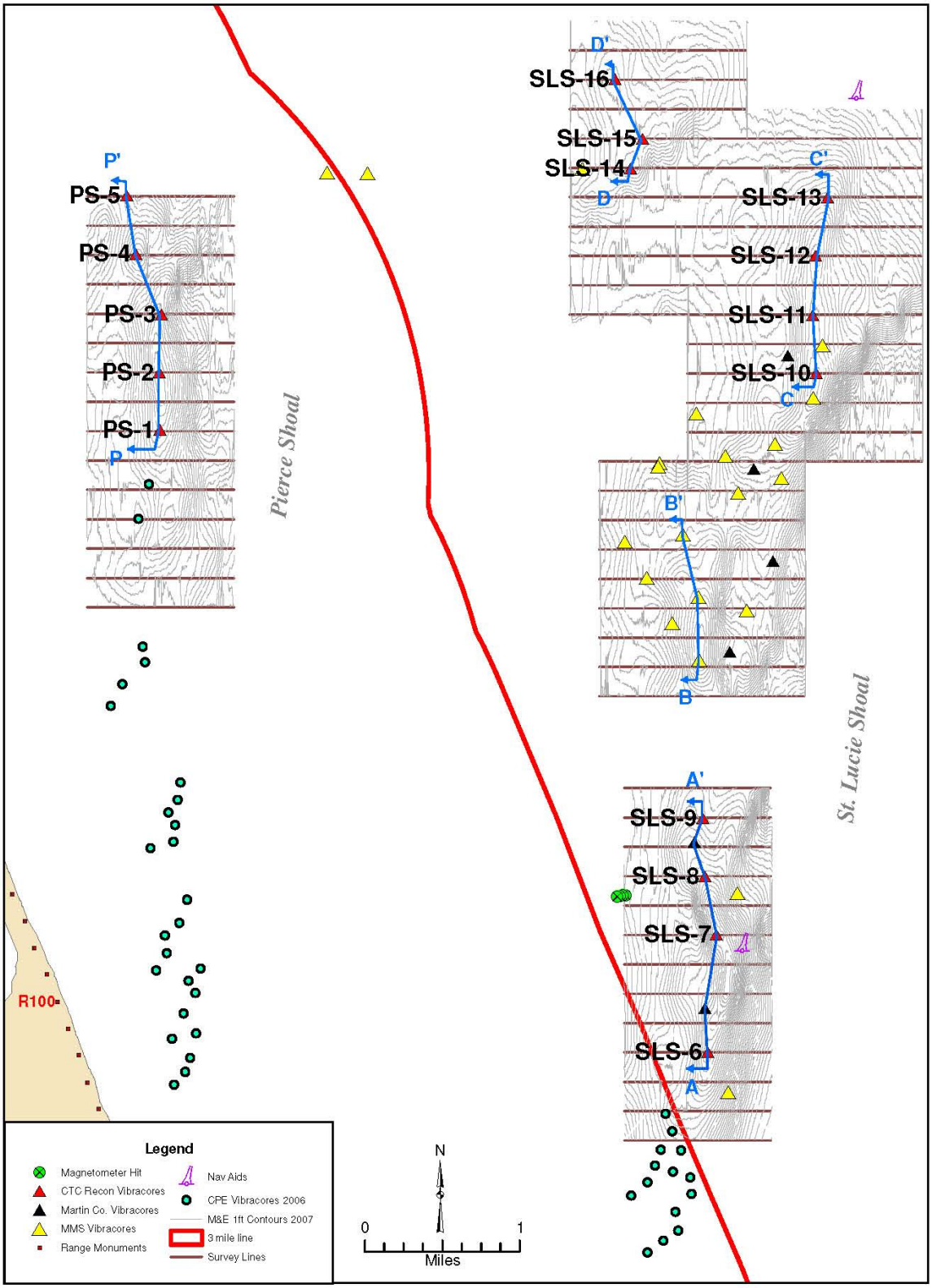


**Figure 5.2: Potential Borrow Areas with Cross-Section Lines**

**Unified Soils Classification Legend**
For use with fence diagrams and vibracore logs

| | | |
|---|---|---|
|  | **SW** | Well graded sands or gravelly sands, <5% fines |
|  | **SM** | Silty sands, sand-silt mixtures, >12% fines |
|  | **GW-GM** | Well-graded silty gravel, 5-12% fines |
|  | **SC-GC** | Sandy, clayey gravels, gravel-sand-clay mixtures, >12% fines |
|  | **SW-SM** | Well graded silty sand, 5-12% fines |
|  | **SP** | Poorly graded sand, or gravelly sands, <5% fines |
|  | **SC** | Clayey sands, sand clay mixtures, >12% fines |
|  | **SP-SM** | Poorly graded silty sand, 5-12% fines |
|  | **CL** | Lean clay, >50% fines |
|  | **GC** | Clayey gravel, gravel-sand-clay mixtures, >12% fines |
|  | **SP-SC** | Poorly graded clayey sand, >12% fines |
|  | **ML** | Inorganic silt and very fine sand, >50% fines |
|  | **LS** | Limestone, lithified sandy-limestone material |
|  | **GM** | Silty gravels, gravel-sand-silt mixtures, >12% fines |

**Table 5.1: Unified Soils Classification System Legend**

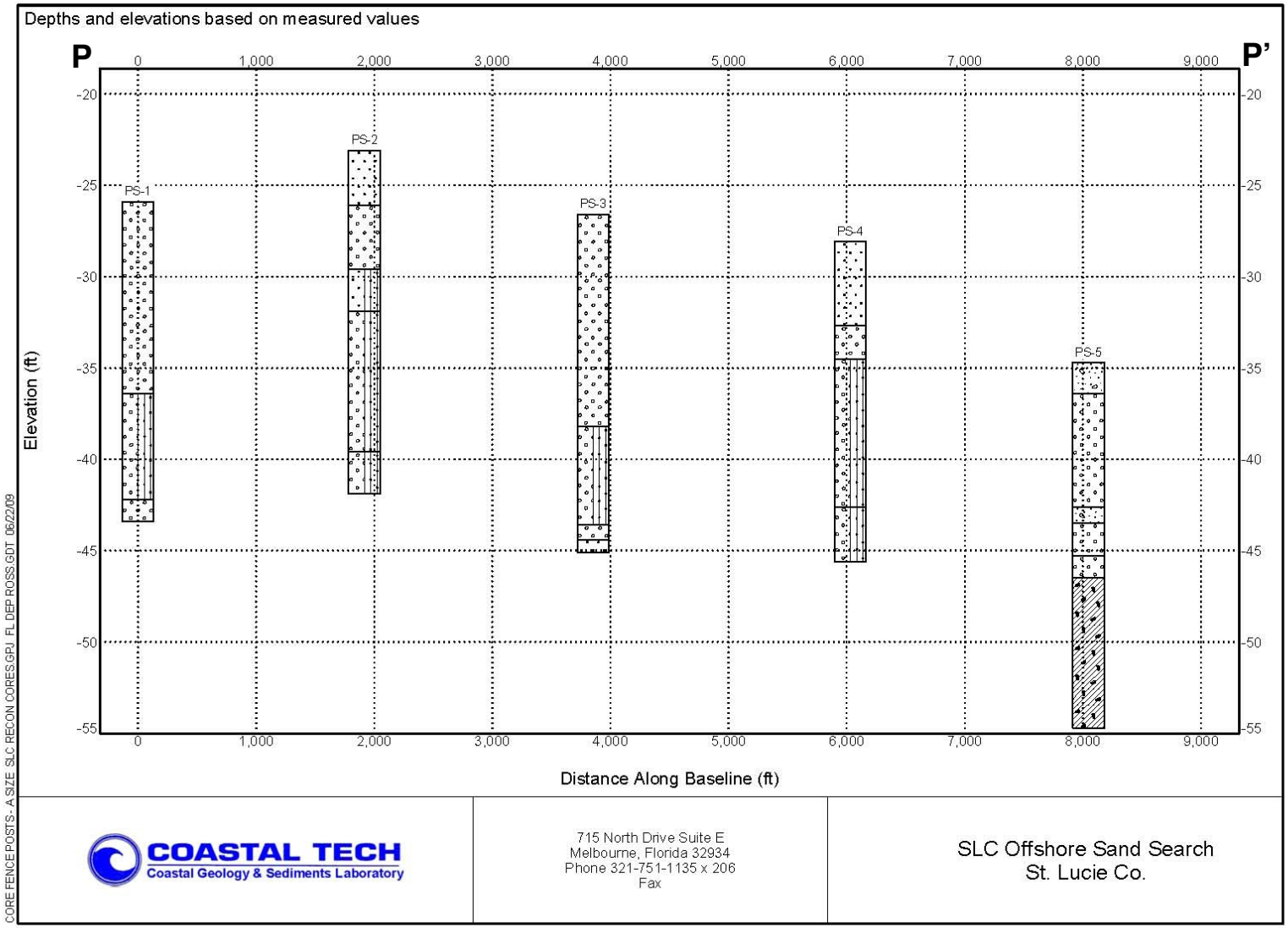


**Figure 5.3: Pierce Shoal Geologic Cross-Section**

Pattern notes: fine stippling = SP, larger stippling = SW, stippling w/vertical lines = sand w/ 5-12% fines, diagonal lines w/ large spots = silty gravel

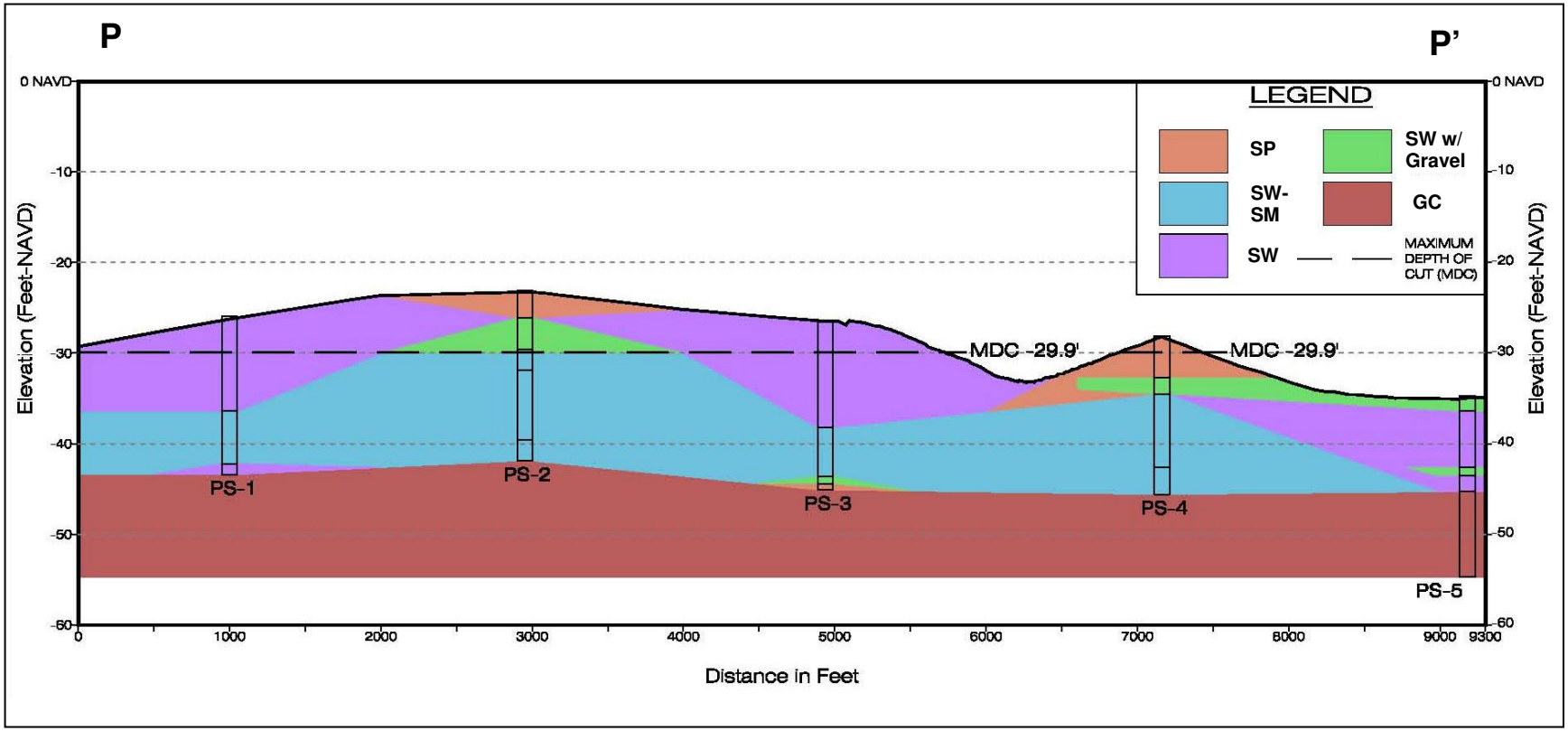


**Figure 5.4: Pierce Shoal – Interpreted Fence Diagram**

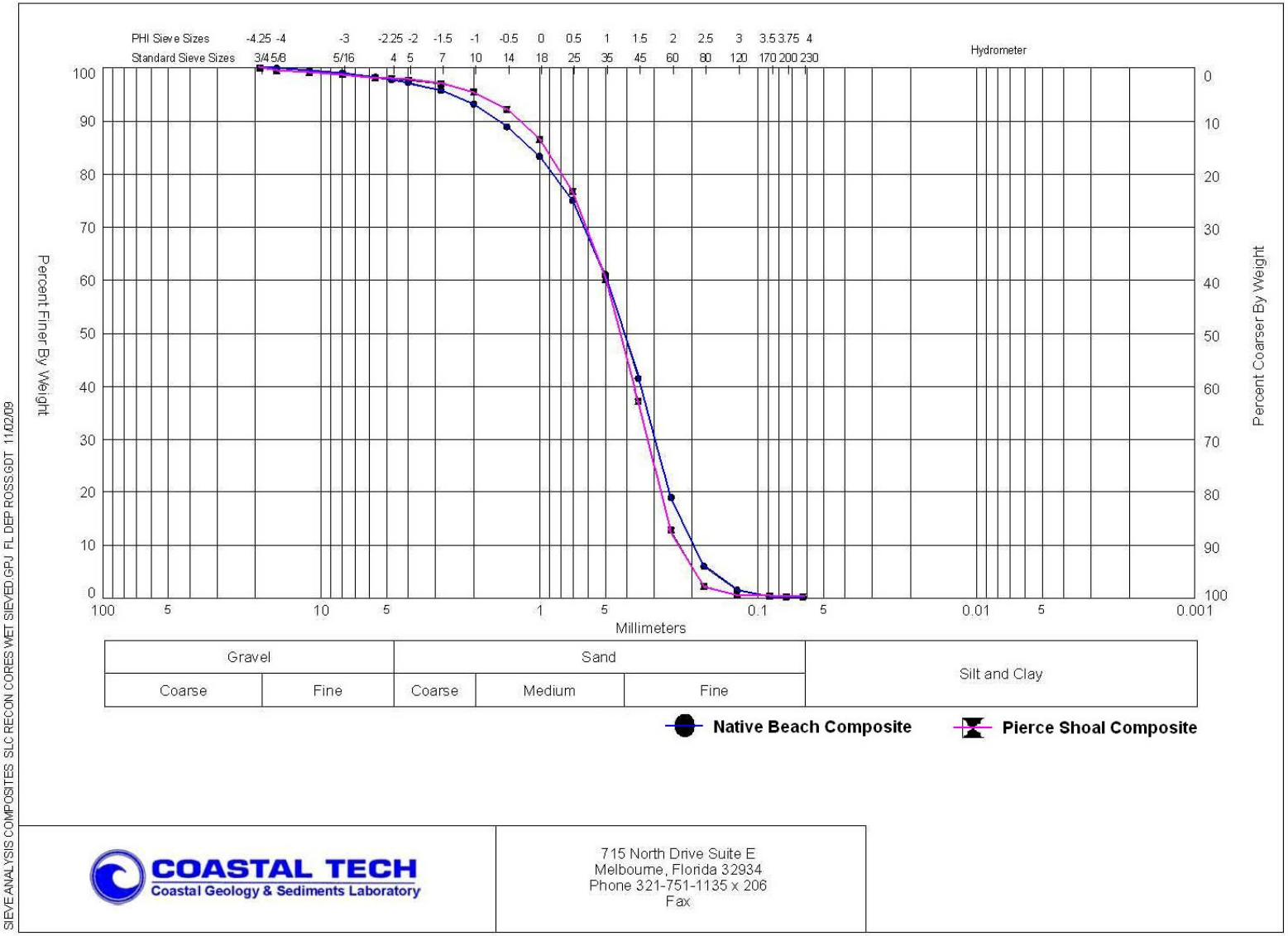


**Figure 5.5: Native Beach and Pierce Shoal: Composite Grain-size Distribution Curves**

On St. Lucie Shoal, in federal water, vibracores were obtained in three areas for the current study; a fourth area is herein delineated around existing vibracores. The four potential borrow areas within St. Lucie Shoal areas are based on bathymetry and vibracores, hereinafter referred to as Areas A-D as shown in Figure 5.1. A polygon, defining the boundary of each potential borrow area, was constructed around the reconnaissance or existing vibracores - extending to the elevation of the recommended maximum depth of cut (as discussed below). These cut depths were established at two feet above the shallowest instance of non-compatible material within the vibracores.

On the southernmost portion of the shoal in Area A, four 20ft vibracores were recovered along the shoal crest. In addition, data were obtained from four existing vibracores (two 20ft MMS vibracores and two 10ft USACE/Martin County vibracores) to further delineate the stratigraphy of this portion of the shoal (Figure 5.1). Vibracores SLS-6 through SLS-9, obtained by Coastal Tech for the current study, penetrated an 8ft to 15ft thick layer of grayish brown skeletal sand with little quartz fraction (Table 5.2 and Figures 5.1, 5.6 and 5.7). The silt content in these cores increased with depth. At approximately -35' NAVD88 Core SLS-07 penetrated a layer of non-compatible silty sand. Silt content increases with depth in Core SLS-08, but this silt content does not reach non-compatibility until -44.6' NAVD88. Although the silt content of SLS-9 increased from about 2% to 3.7% from near the surface to the bottom of the core, it never penetrated a non-compatible layer. Core SLS-6 penetrated a non-compatible layer at approximately -41.3' NAVD88.

Area A was separated into 3 sub-sections with different maximum depths of cut in order to optimize the potential volume of sediment that may be extracted (Figure 5.1). Using maximum depths of cut of -39.3, -33.0, and -42.6 NAVD88 from the southern to the northern sub-sections respectively, Area A could yield a total of approximately 7.4mcy of beach compatible material. A composite was calculated from the samples above the maximum depths of cut from the Coastal Tech vibracores only, and the composite grain-size distribution curve is compared against the native beach composite in Figure 5.8. Samples were weighted vertically within the core, but all cores were weighted equally within the borrow area. This composite indicates that the material in Area A, (including all subsections) is medium grained (0.50mm), moderately sorted skeletal sand with <3% fines and <1% gravel content, and is composed of 82.3% carbonate. The *Overfill Factor* for this section based on these data is 1.15 against the native beach characteristics for the current study, 1.0 against the 1990 characteristics, and 1.5 against the 1965 native beach characteristics.

| Shoal Segment | Core # | Sand Recovered (feet) | Sand Above Proposed Cut (feet) | gINT Granularmetrics | | | | | | | USC | Carbonate Content (wt%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Size Class (wt%) | | | | Descriptive Statistics | | | | |
| | | | | *Gravel* | *Sand* | *<#200* | *<#230* | *Mean (mm)* | *Verbal* | *Std. Dev.(phi)* | | |
| **Pierce Shoal** | PS-1 | 10.5 | 4.0 | 1.46 | 98.34 | 0.20 | 0.14 | 0.45 | M | 1.02 | SW | 80.1 |
| | PS-2 | 8.8 | 6.8 | 5.63 | 93.75 | 0.62 | 0.48 | 0.74 | M | 1.36 | SW | 85.7 |
| | PS-3 | 17.0 | 3.3 | 0.46 | 99.37 | 0.17 | 0.13 | 0.41 | F | 0.84 | SP | 75.6 |
| | PS-4 | 4.6 | 1.8 | 0.81 | 99.03 | 0.16 | 0.15 | 0.44 | M | 0.85 | SP | 76.7 |
| **St. Lucie Shoal: Area A** | SLS-6 | 15.5 | 13.5 | 0.20 | 97.47 | 2.33 | 2.17 | 0.45 | M | 0.84 | SP | 79.4 |
| | SLS-7 | 15.0 | 13.0 | 0.57 | 96.93 | 2.50 | 2.37 | 0.54 | M | 0.91 | SW | 83.5 |
| | SLS-8 | 17.0 | 15.0 | 0.30 | 96.45 | 3.25 | 3.01 | 0.48 | M | 0.88 | SW | 82.6 |
| | SLS-9 | 18.4 | 8.1 | 0.78 | 97.14 | 2.08 | 1.99 | 0.55 | M | 0.93 | SW | 83.5 |
| **St. Lucie Shoal: Area C** | SLS-10 | 16.0 | 14.0 | 0.04 | 97.98 | 1.98 | 1.87 | 0.49 | M | 0.75 | SP | 82.1 |
| | SLS-11 | 15.7 | 12.2 | 0.12 | 97.55 | 2.33 | 2.21 | 0.50 | M | 0.90 | SW | 81.7 |
| | SLS-12 | 16.0 | 13.2 | 0.32 | 97.45 | 2.23 | 2.10 | 0.42 | F | 0.87 | SW | 79.5 |
| | SLS-13 | 7.5 | 6.0 | 1.36 | 97.59 | 1.05 | 1.00 | 0.45 | M | 0.95 | SW | 80.3 |
| **St. Lucie Shoal: Area D** | SLS-14 | 8.5 | 3.6 | 0.21 | 98.81 | 0.98 | 0.94 | 0.39 | F | 0.74 | SP | 75.2 |
| | SLS-15 | 3.9 | 1.9 | 1.50 | 96.99 | 1.51 | 1.42 | 0.40 | F | 1.18 | SW | 77.2 |
| | SLS-16 | 6.9 | 3.9 | 0.31 | 98.30 | 1.39 | 1.34 | 0.43 | F | 0.85 | SP | 78.9 |

**Table 5.2: Vibracore Sedimentology for Potential Borrow Areas**

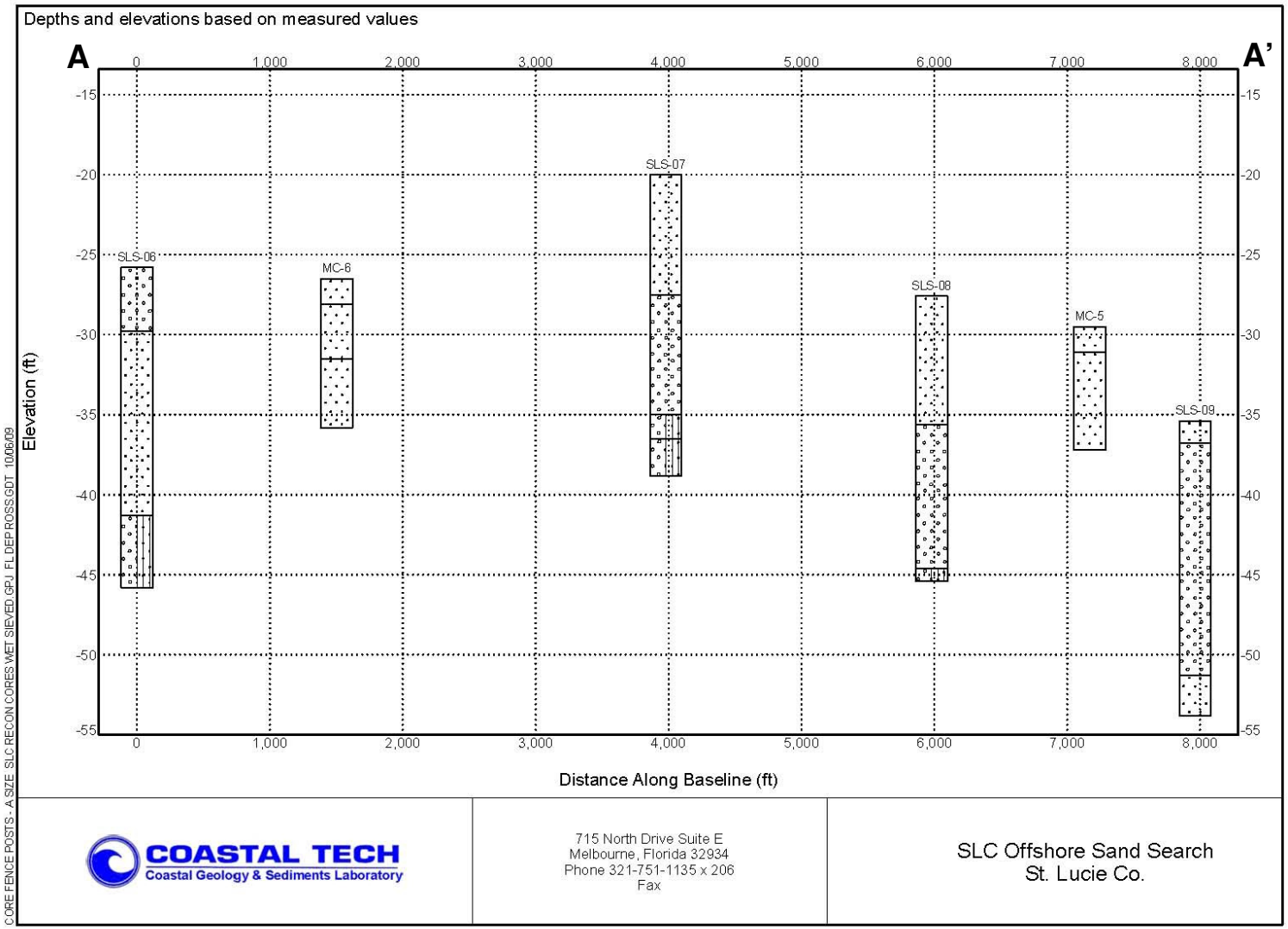


**Figure 5.6: St. Lucie Shoal: Area A – Geologic Cross-Section**

Pattern notes: fine stippling = SP, larger stippling = SW, stippling w/vertical lines = sand w/ 5-12% fines

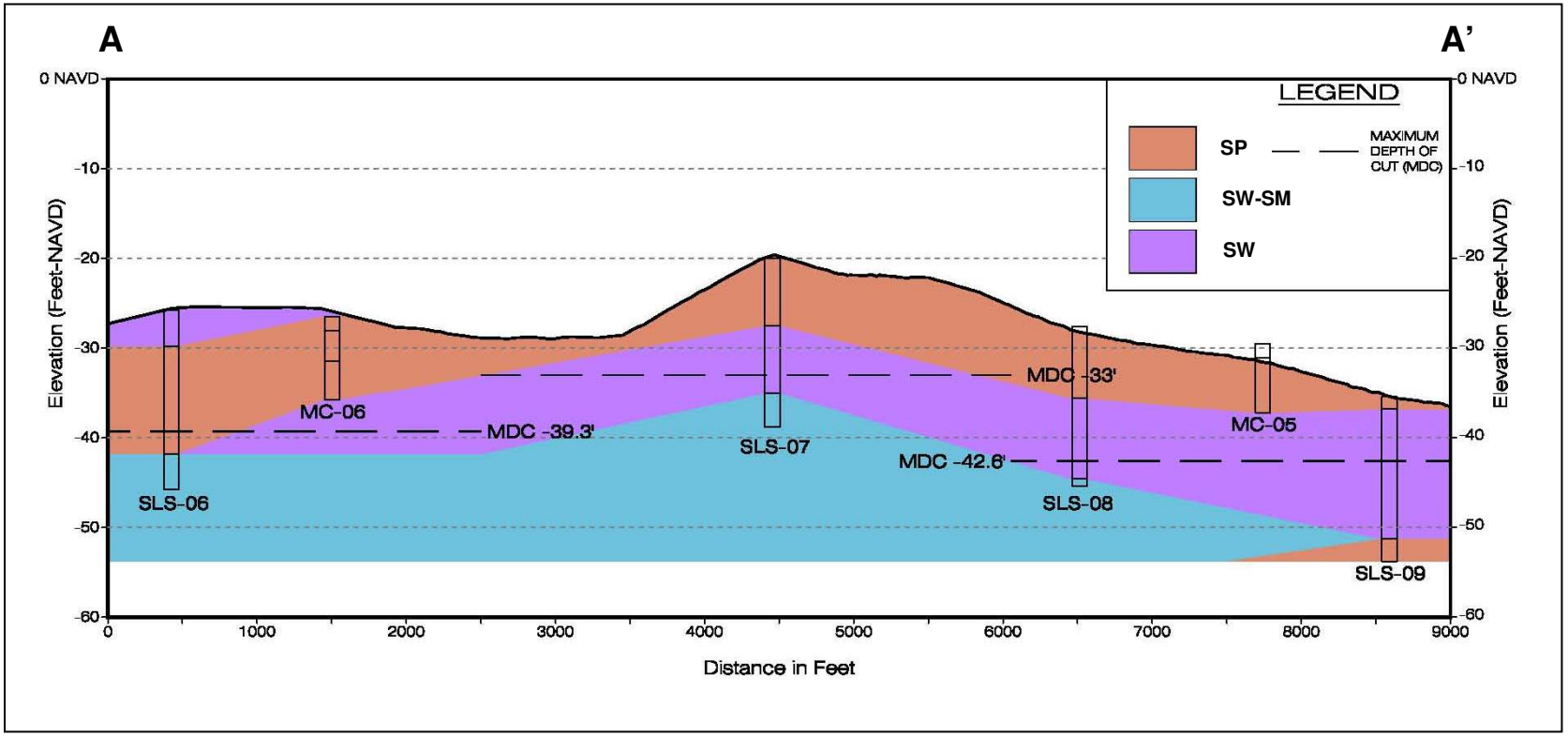


**Figure 5.7: St. Lucie Shoal: Area A – Interpreted Fence Diagram**

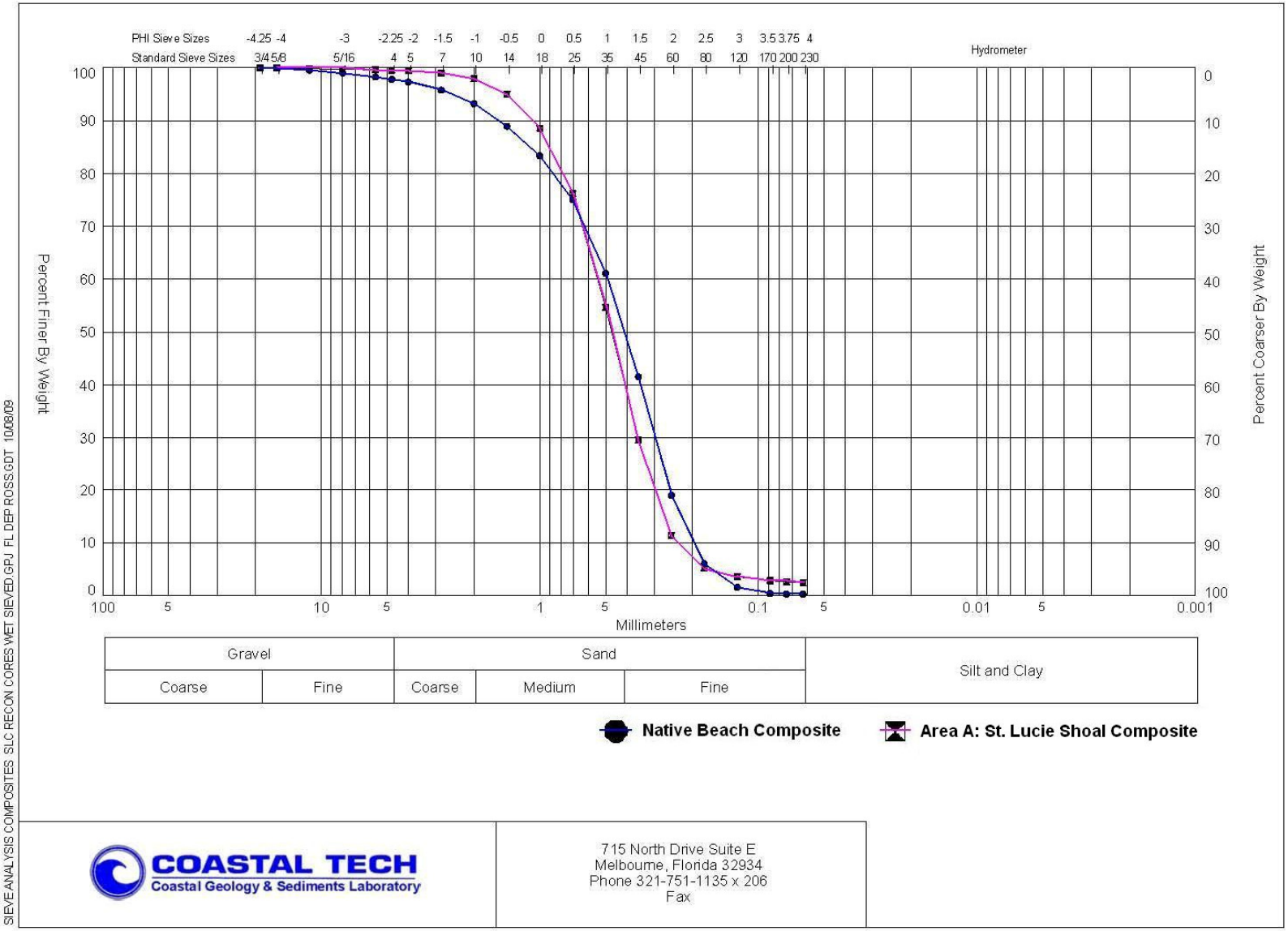


**Figure 5.8: Native Beach and St. Lucie Shoal: Area A Composite Grain-size Distribution Curves**

For Area A, the data from the FGS/MMS report regarding samples obtained from vibracores VSL-6 indicate that samples above the recommended maximum depth of cut are beach compatible, though finer grained than those obtained from vibracores from the current study. The FGS/MMS samples indicate that the material is fine grained (0.30mm), with less than 1% fines and composed of 75% carbonate. No sample analysis results were included from vibracore VSL-4 (obtained by others) because the assumed elevation of the top-of-core is below the recommended maximum depth of cut. The two vibracores taken in association with the Martin County, although of limited length, never encountered a non-compatible layer.

North of Area A is Area B, where no vibracores were placed for the current study as data were available from existing vibracores associated with the FGS/MMS study and the Martin County/ACOE study. Data in Area B include thirteen (13) vibracores taken in conjunction with the 2002 FGS/MMS study, and three (3) vibracores taken in conjunction with the 2006 USACE/Martin County sand search as illustrated in Figure 5.1 and summarized in Table 5.3. Area B was broken down into three sub-areas with different maximum depths of cut, in order to maximize potential volume. The maximum depths of cut in the three sub-sections range from -46.5', -39.0', to -49.5' NAVD, from south to north, respectively. Based on these cut depths, Area B in total is estimated to yield approximately 7.3 million cubic yards of material. The data from the FGS/MMS study show that the sediment above these cut depths (for all sub-sections) is moderately sorted, fine grained (0.40mm) predominately carbonate sand with less than 2% fines. The *Overfill Factor* for these data is 1.0 against the native beach for the current study, 1.0 against the 1990 native beach, and 1.5 against the 1965 native beach data. Vibracore number 2 from the Martin County/ACOE project showed poor material that was classified as well-sorted sand with 5-12% fines (SP-SM), so the potential borrow area excludes this core. The samples from the other two Martin County/ACOE vibracores were all classified as well sorted sand (SP).

Four 20 foot vibracores were obtained by Coastal Tech for the current study from Area C, as shown in Figure 5.1. These vibracores reflect a roughly 16ft layer of beach compatible sand as illustrated in Figures 5.9 and 5.10. Vibracore SLS-13, which extends deeper than the other three vibracores, penetrated a narrow layer of sediment with a non-compatible gravel content at -42.7' NAVD88. This layer is only 0.8' in thickness within the core, and is underlain by compatible sediment similar to the overlying layer. This gravel layer is thicker in the vibracores taken in Area D, to the northwest of Area C, where it begins at a similar depth. Using a maximum depth of cut of -41.2' NAVD88 along Area C, a volume of approximately 6mcy of beach compatible material could be excavated. A composite was calculated for all samples above the maximum depth of cut and the composite grain-size distribution curve is shown against the native beach composite in Figure 5.11.

| Segment | Vibracore | Vibracore Length (feet) | Mean (mm) | Fines (wt%) | Carbonate (wt%) | Std. Dev. (phi) |
|---|---|---|---|---|---|---|
| **South** | VSLA-1 | 16.5 | 0.40 | 1.70 | 87 | 0.74 |
| | VSLA-11 | 6.5 | 0.40 | 1.43 | 88 | 0.91 |
| **Mid** | VSLA-2 | 6 | 0.38 | 2.00 | 88 | 0.77 |
| **North** | VSLA-3 | 10 | 0.39 | 1.40 | 89 | 0.81 |
| | VSLA-4 | 9.5 | 0.57 | 1.50 | 90 | 0.99 |
| | VSLA-9A | 7.5 | 0.31 | 1.38 | 87 | 1.38 |
| | VSL-8 | 4.5 | 0.36 | 0.77 | 85 | 0.69 |
| | | **AVG** | **0.40** | **1.45** | **87.71** | **0.90** |

*Data extracted from *A Geological Investigation of Sand Resources Along Florida's Central-East Coast* (Hoenstine et al, 2002). Length and characteristics calculated from sample data from samples above recommended maximum depth of cut only.

**Table 5.3: FGS/MMS Vibracore Sample Data for Area B**

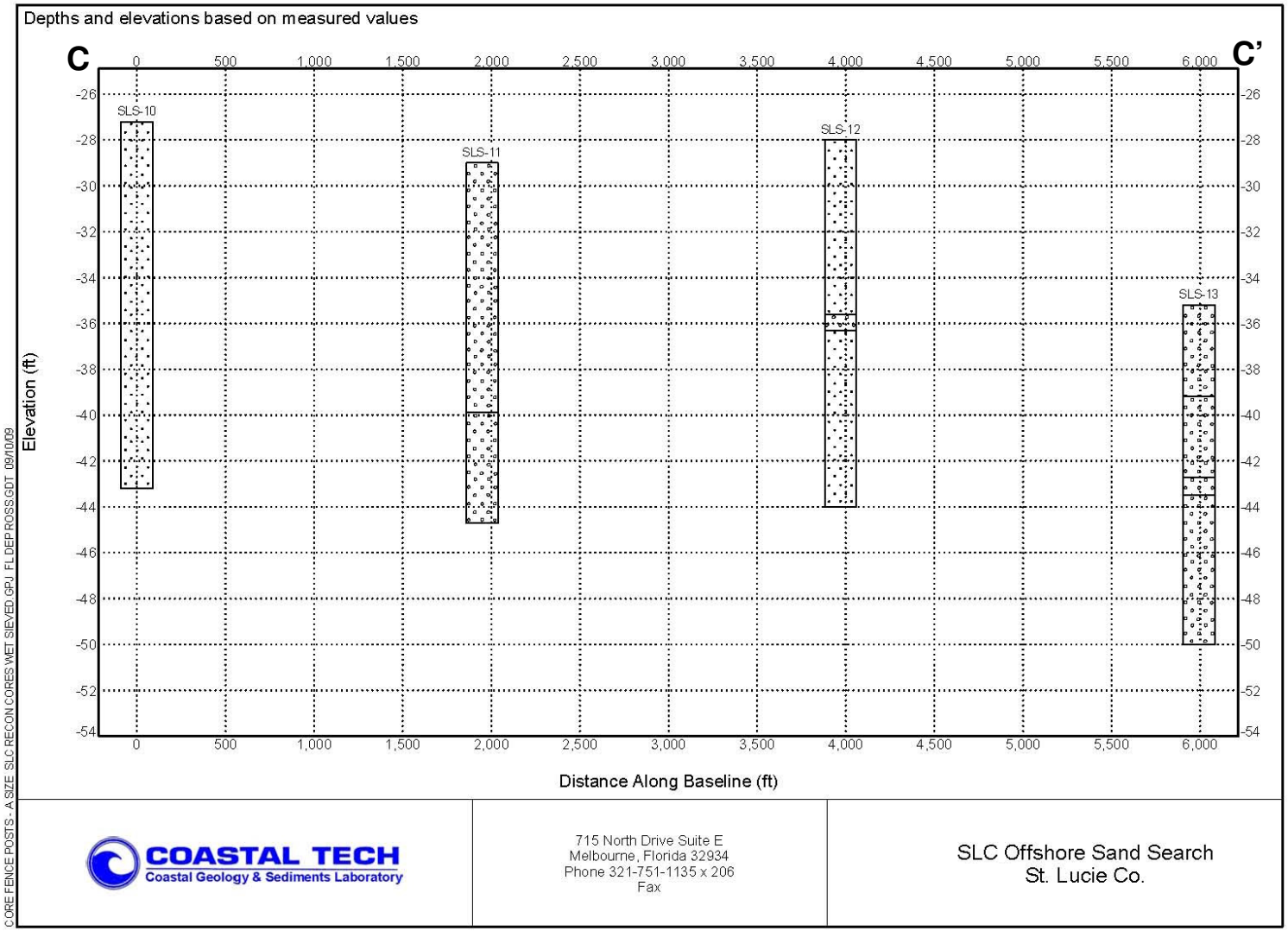


**Figure 5.9: St. Lucie Shoal: Area C – Geologic Cross-Section**

Pattern notes: fine stippling = SP, larger stippling = SW

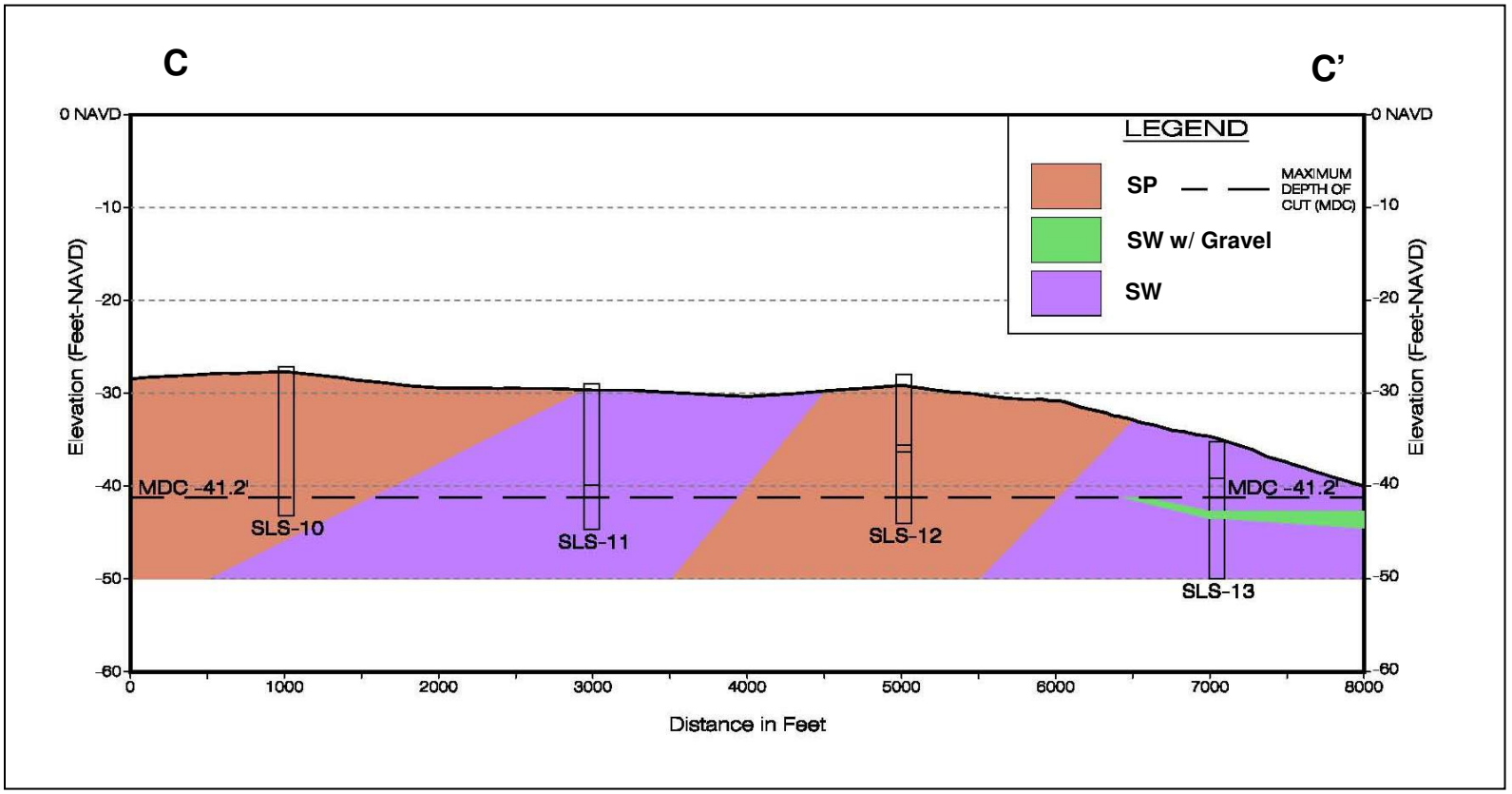


**Figure 5.10: St. Lucie Shoal: Area C – Interpreted Fence Diagram**

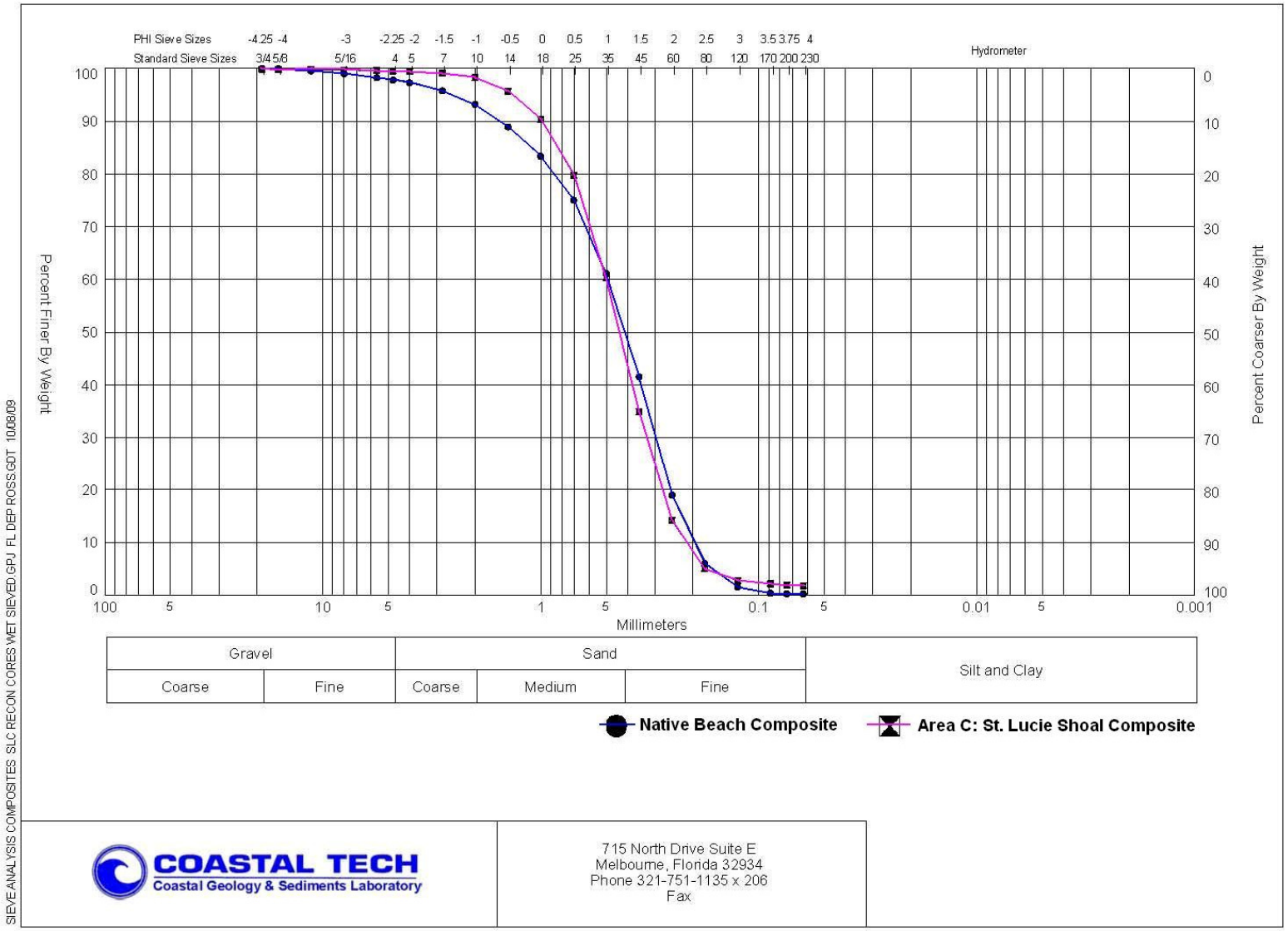


**Figure 5.11: Native Beach and St. Lucie Shoal: Area C Composite Grain-size Distribution Curves**

This composite indicates that the material is medium grained (0.46mm), moderately sorted, predominately carbonate sand with little quartz fraction, and increasing fines with depth, an average of <2% fines, <1% gravel content, and is composed of approximately 81% carbonate material. Using these data the *Overfill Factor* would be 1.50 against current native beach characteristics, 1.0 against 1990 characteristics, and 2.0 against the 1965 native beach characteristics.

Three (3) vibracores were extracted by Coastal Tech from Area D on St. Lucie Shoal shown in Figure 5.1. The vibracores penetrated a compatible sand layer approximately 4ft - 8.5ft thick as shown in Figures 5.12 and 5.13. This layer is underlain by a non-compatible layer of skeletal sand with up to 28% gravel content, which has a thickness of up to 3.8ft. Using a conservative maximum depth of cut of -38.2' NAVD88 along Area D, a volume of approximately 464,400 cubic yards of beach compatible material could be excavated. A composite was calculated using only the samples obtained above this maximum depth of cut and the composite curve is shown against the native composite in Figure 5.14. This composite indicates that the material is fine grained (0.41mm), moderately sorted, predominately carbonate sand, <2% fines, <1% gravel, and is composed of approximately 77% carbonate material. Using these data, the *Overfill Factor* would be 2.25 against the current native beach characteristics, 1.10 against the 1990 characteristics, and 2.5 against the 1965 native beach characteristics. It is likely that this material is finer grained due to a slightly lower carbonate content than the other shoal areas.

## 6.0 Plans and Specs Level Investigation Plan

COASTAL TECH has prepared a *Plans & Specs-Level Investigation Plan* that is designed to further quantify potential offshore borrow areas capable of providing beach compatible sand to St. Lucie County – sufficient for bidding and construction. The plans and specs-level investigation proposed herein focuses on the federal portion of St. Lucie Shoal - as illustrated in Figure 6.1. If the plans and specs-level results indicate that Area A has adequate beach-quality material, this area will be utilized for the 50 year life of the project and emergency needs, with appropriate provisions to avoid and minimize impacts to pelagic fish habitat. .

### 6.1 Task 3a – Borrow area offshore investigation

The target volume of beach compatible sand sought for the current and long term needs of the St. Lucie County beaches has been identified as approximately 25 million cubic yards of material. Based on findings outlined in this report, Coastal Tech estimates that the federal portion of St. Lucie Shoal may contain approximately 21.13 million cubic yards of beach quality material. Coastal Tech proposes to initiate a plans and specs level investigation that will attempt to identify this volume of beach compatible sand by acquiring: (1) thirty-eight 10 foot vibracores and (2) eighty-one 20 foot vibracores. Subsequently, compatibility analysis, and a full report will be completed on behalf of St. Lucie County.

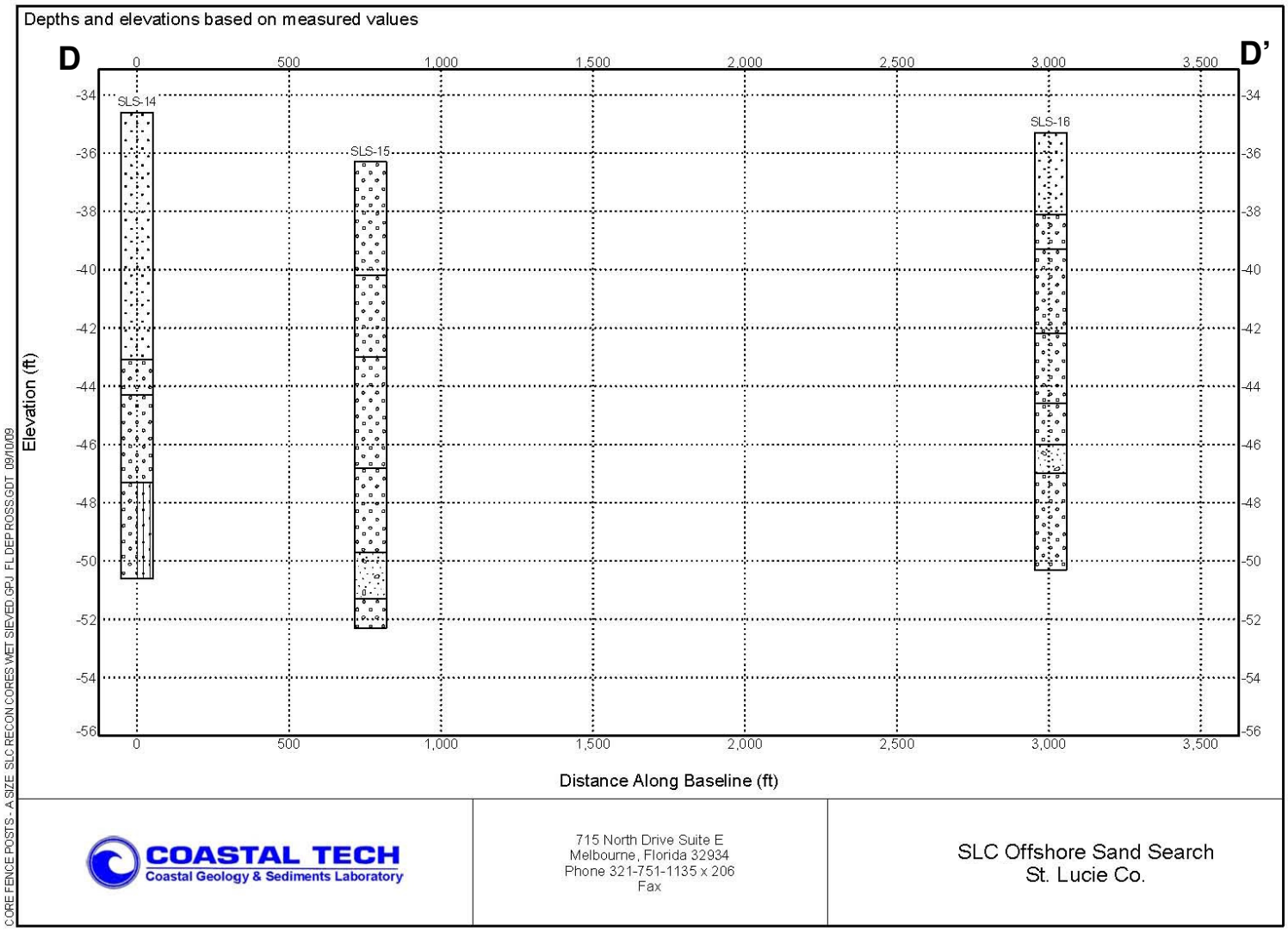


**Figure 5.12: St. Lucie Shoal: Area D – Geologic Cross-Section**

**Pattern notes: fine stippling = SP, larger stippling = SW, stippling w/vertical lines = sand w/ 5-12% fines, stippling w/ large spots = gravel**

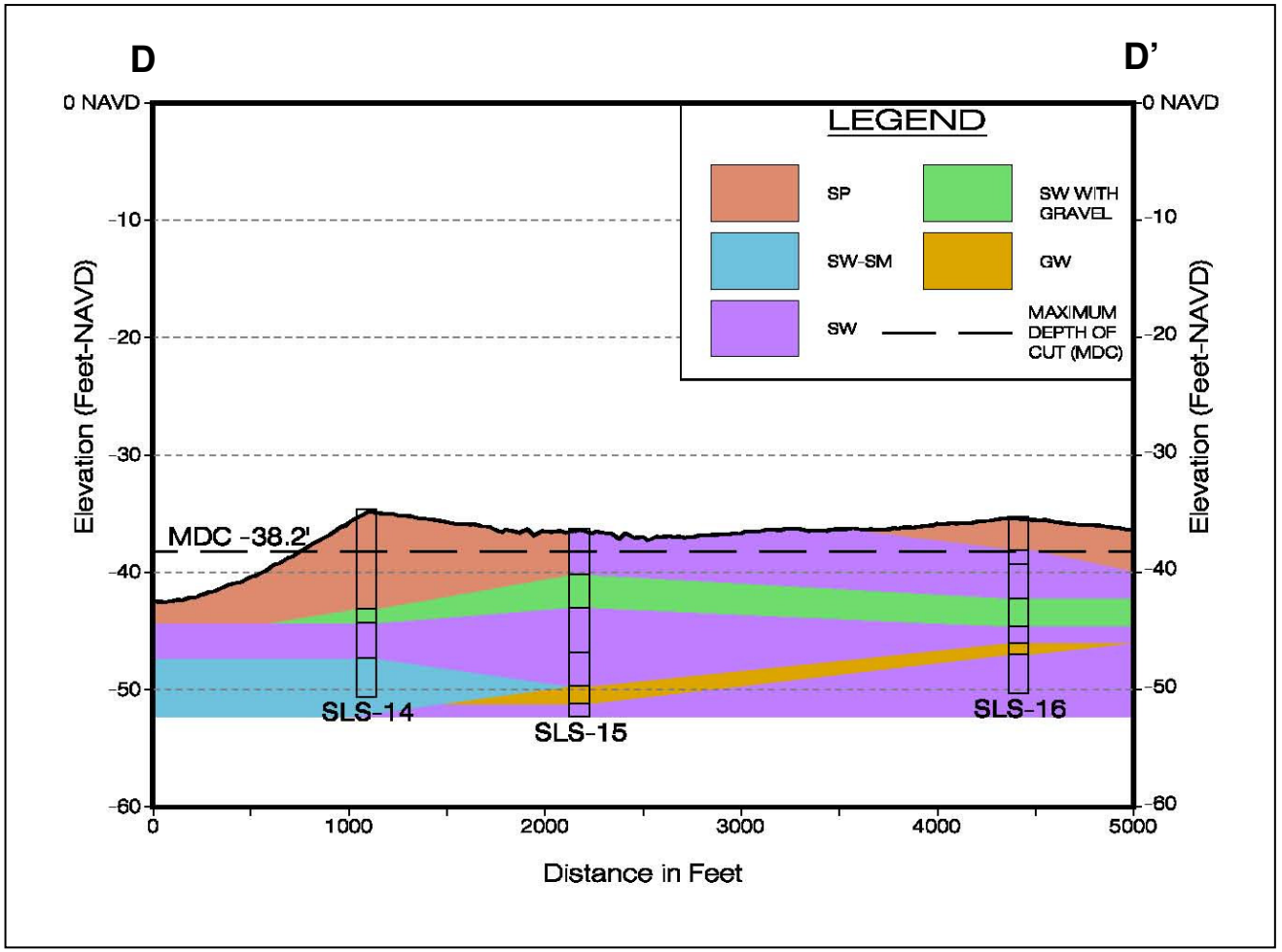


**Figure 5.13: St. Lucie Shoal: Area D – Interpreted Fence Diagram**

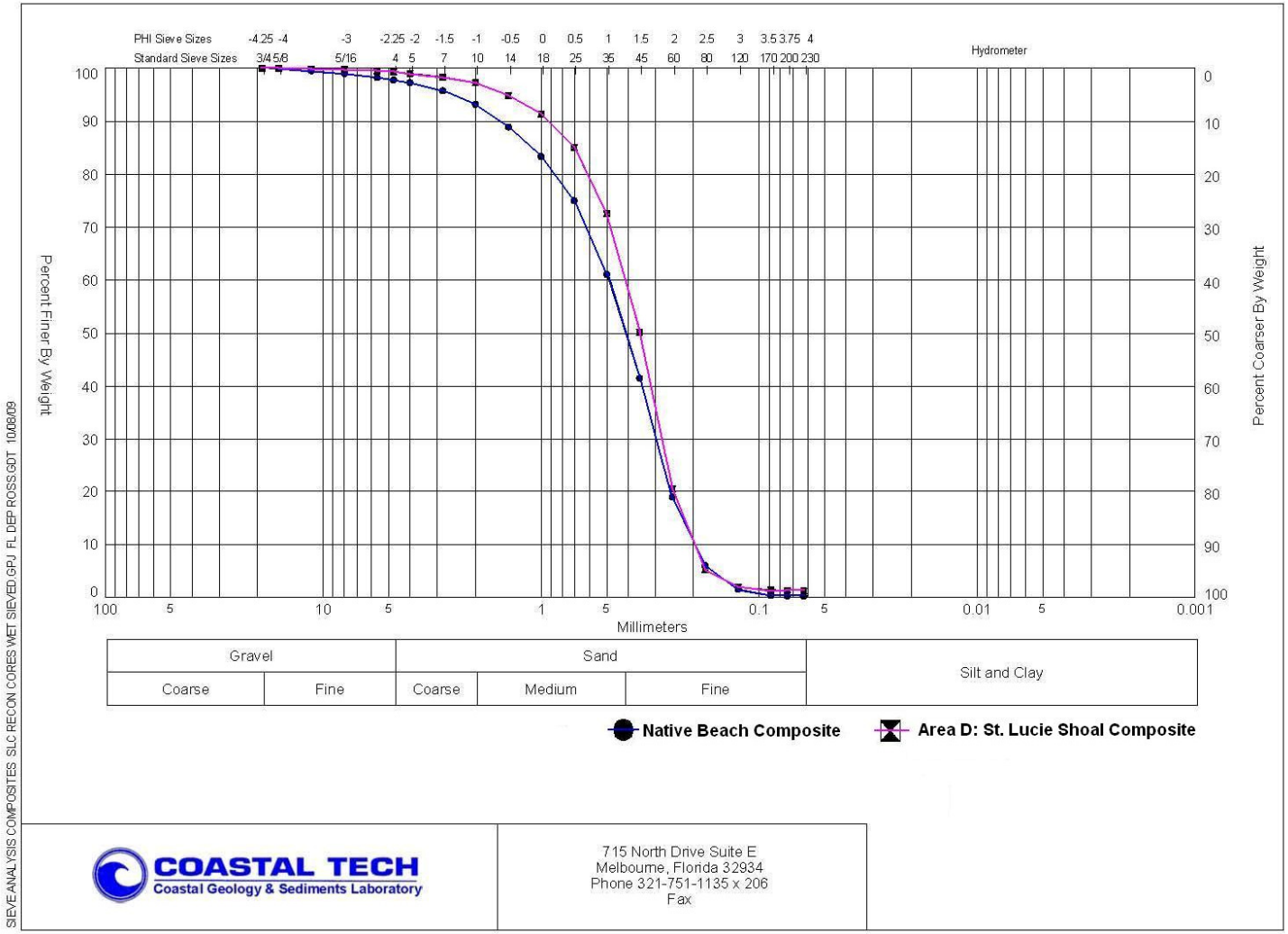


**Figure 5.14: Native Beach and St. Lucie Shoal: Area D Composite Grain-size Distribution Curves**

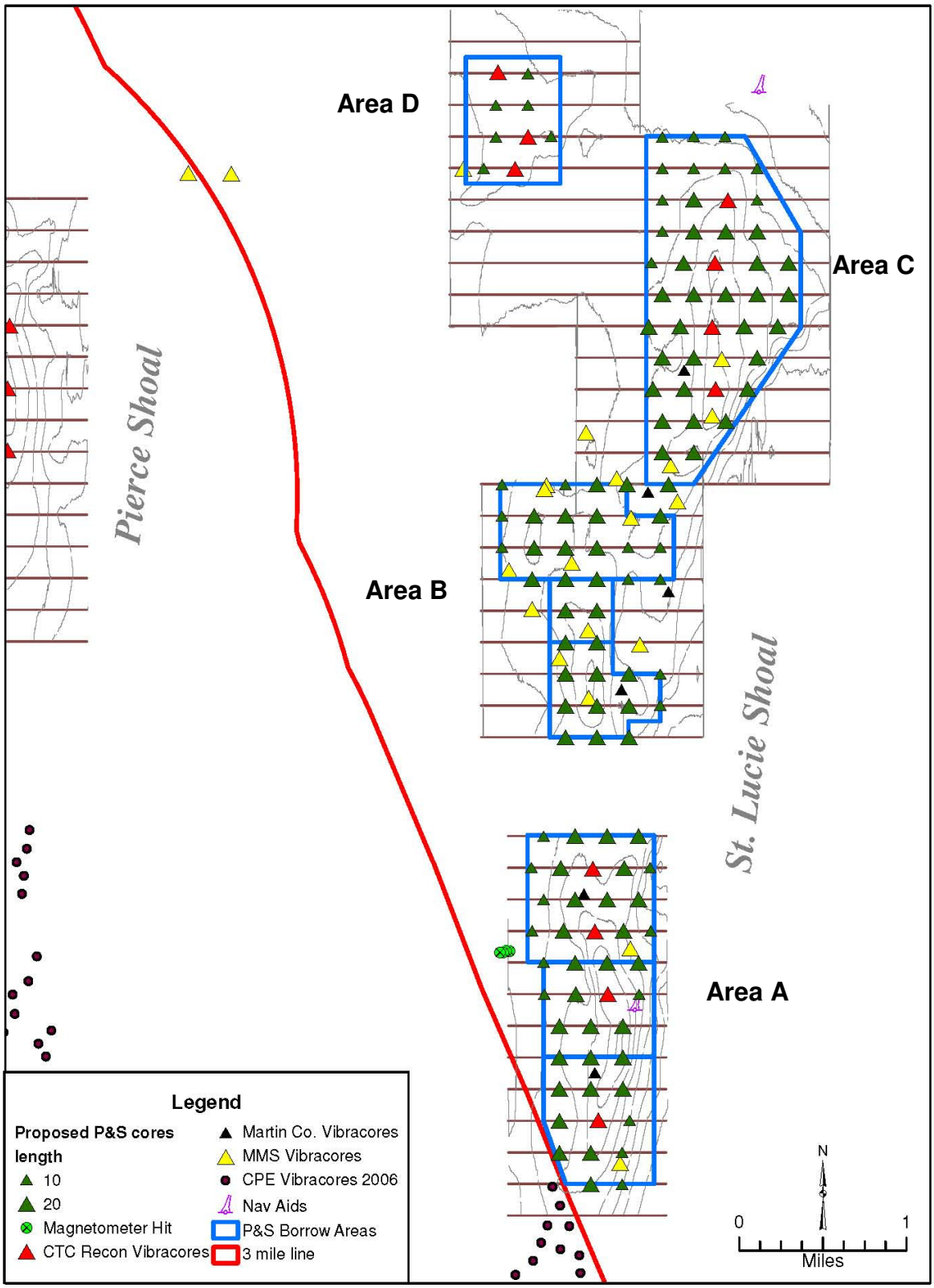


**Figure 6.1: Proposed Plans and Specs Vibracoring Plan**

The proposed location of plans and specs level vibracores is illustrated in Figures 6.1-6.5, and is based upon FDEP standards. Proposed vibracore locations have been arranged using a grid pattern with spacing generally equal to 1,000 feet. Vibracore lengths have been selected to ensure the upper sand layer is penetrated to the maximum extent possible and that a portion of the underlying non-compatible material is recovered at some locations.

## 6.2 Task 3b – Vibracore logs and sediment analysis

Upon transferring the plans and specs-level vibracores to Coastal Tech's Coastal Geology and Sediments Laboratory, each will be split longitudinally, logged, and photographed. Sediment samples will be acquired from each major sediment horizon and thereafter each vibracore will be encased in a plastic liner, boxed, and stored for up to 60 days after the submittal of the final report before transferring all archived vibracores back to the County or appropriate state entity. Coastal Tech will conduct sedimentological analysis of vibracore sediment samples in accordance with methods utilized during the reconnaissance-level investigation (Task 2c).

## 6.3 Task 3c – Borrow area delineation and compatibility analysis

Plans and specs-level potential borrow area delineation and analysis will be based upon the same methodologies described in the reconnaissance-level investigation (Task 2d).

## 6.4 Task 3d – Seismic survey

A complete side-scan sonar, magnetometer and sub-bottom profiler survey of the potential borrow areas was conducted by Southeastern Archaeological Research, Inc. (SEARCH) in support of the St. Lucie and Martin Counties Shore Protection Projects from September 2007 through June 2008 on behalf of the USACE. The surveys were conducted at approximately 100' spacing throughout the borrow areas, and a letter from the Division of Historical Resources was obtained confirming that the potential borrow areas are free of historical or cultural resources. As a result, additional seismic surveys are not planned at this time, unless required by regulatory staff.

## 6.5 Task 3e – Bathymetric survey

A bathymetric survey was performed in August 2007 at a spacing of 1000' throughout the borrow area. Additional surveying is not warranted or planned.

## 6.6 Task 3f – Final geotechnical report

Coastal Tech will prepare a final report summarizing all Task 3 results. The Final Report, in digital *pdf* format, will be provided to the County, FDEP the ACOE District. Coastal Tech will provide hardcopies of the Final Report to all who require them. Coastal Tech will meet with the County, the ACOE District, and FDEP staff to review and revise this report.

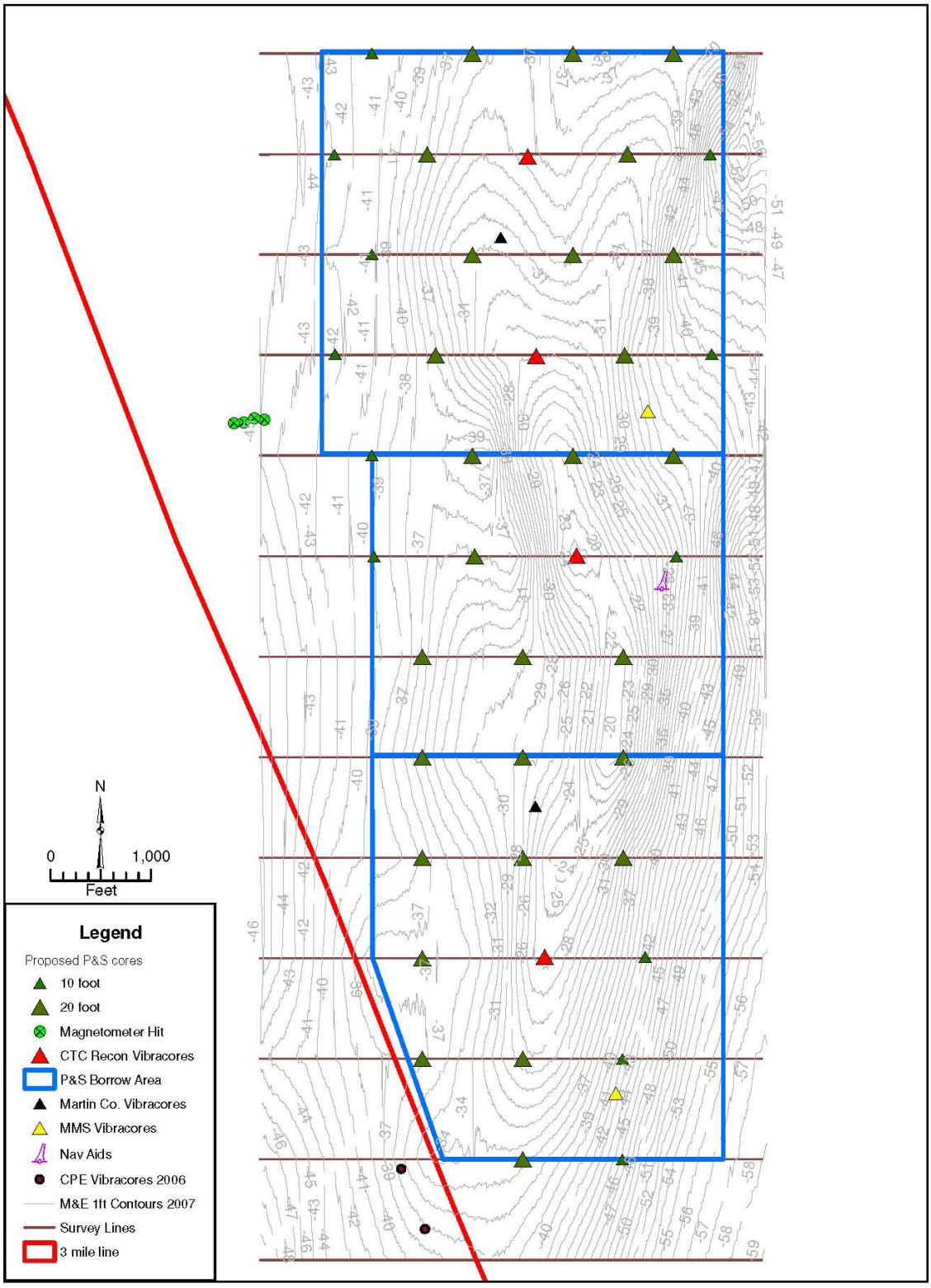


**Figure 6.2: Proposed Plans and Specs Vibracoring Plan: Area A**

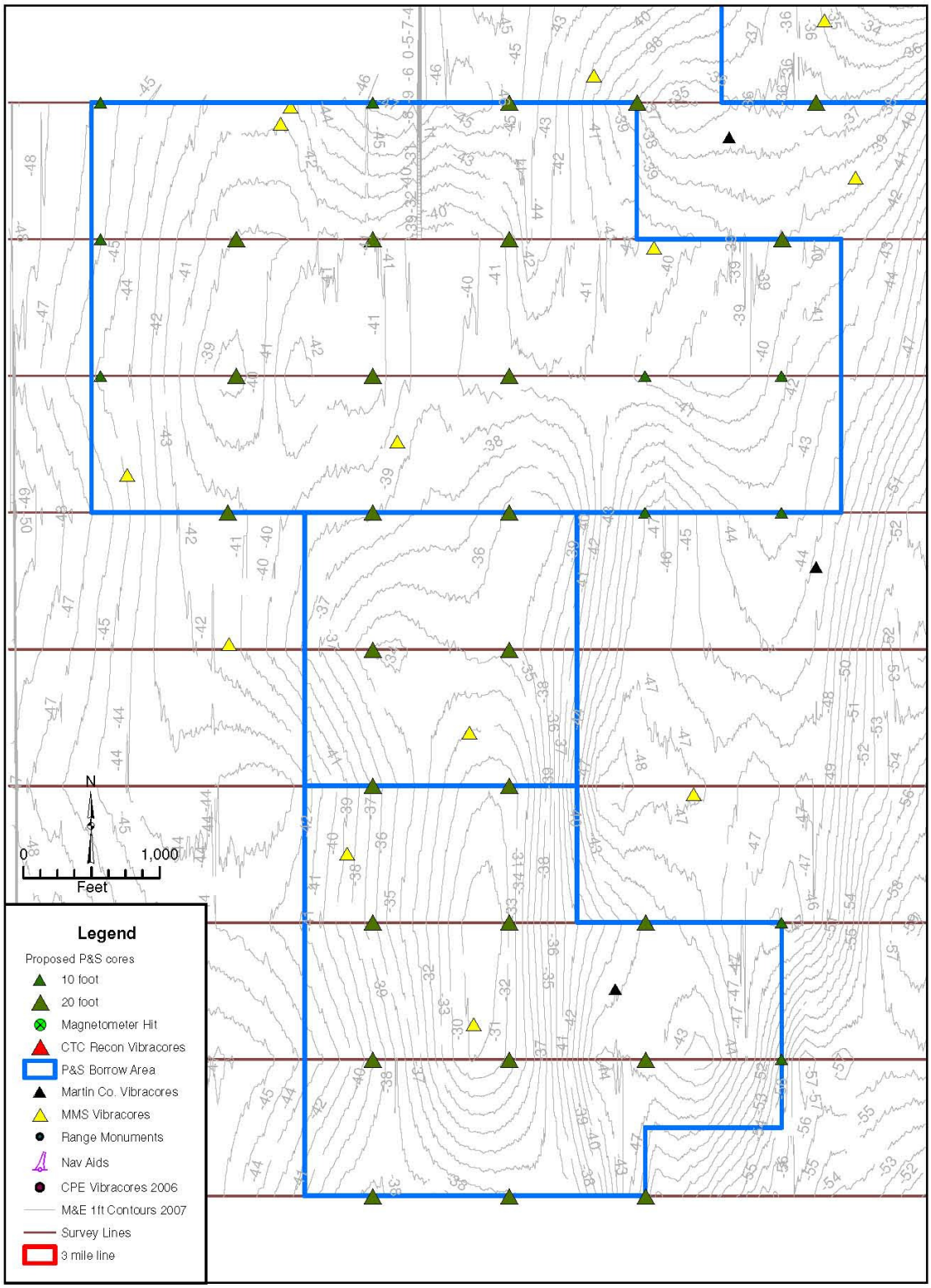


**Figure 6.3: Proposed Plans and Specs Vibracoring Plan: Area B**

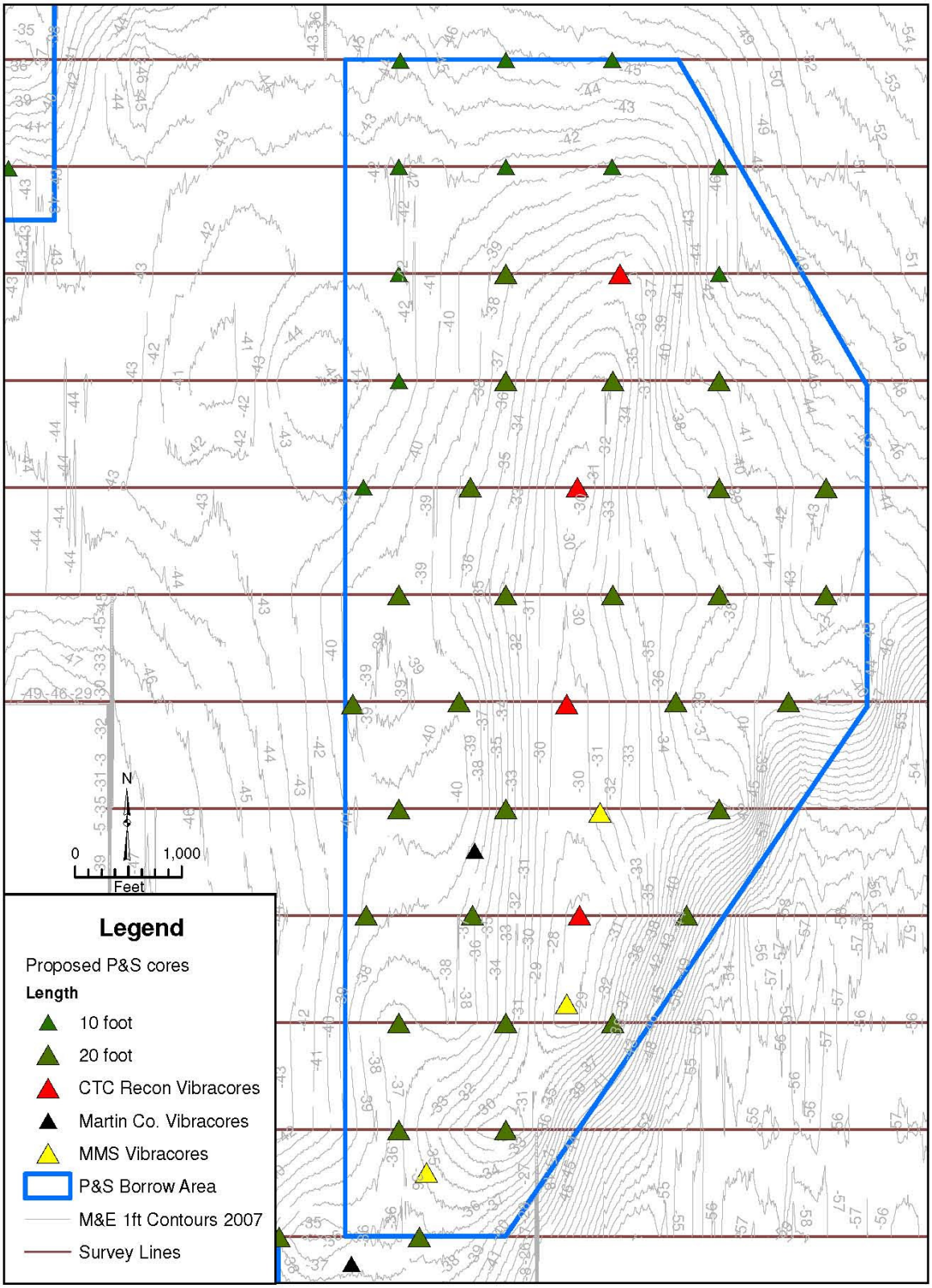


**Figure 6.4: Proposed Plans and Specs Vibracoring Plan: Area C**

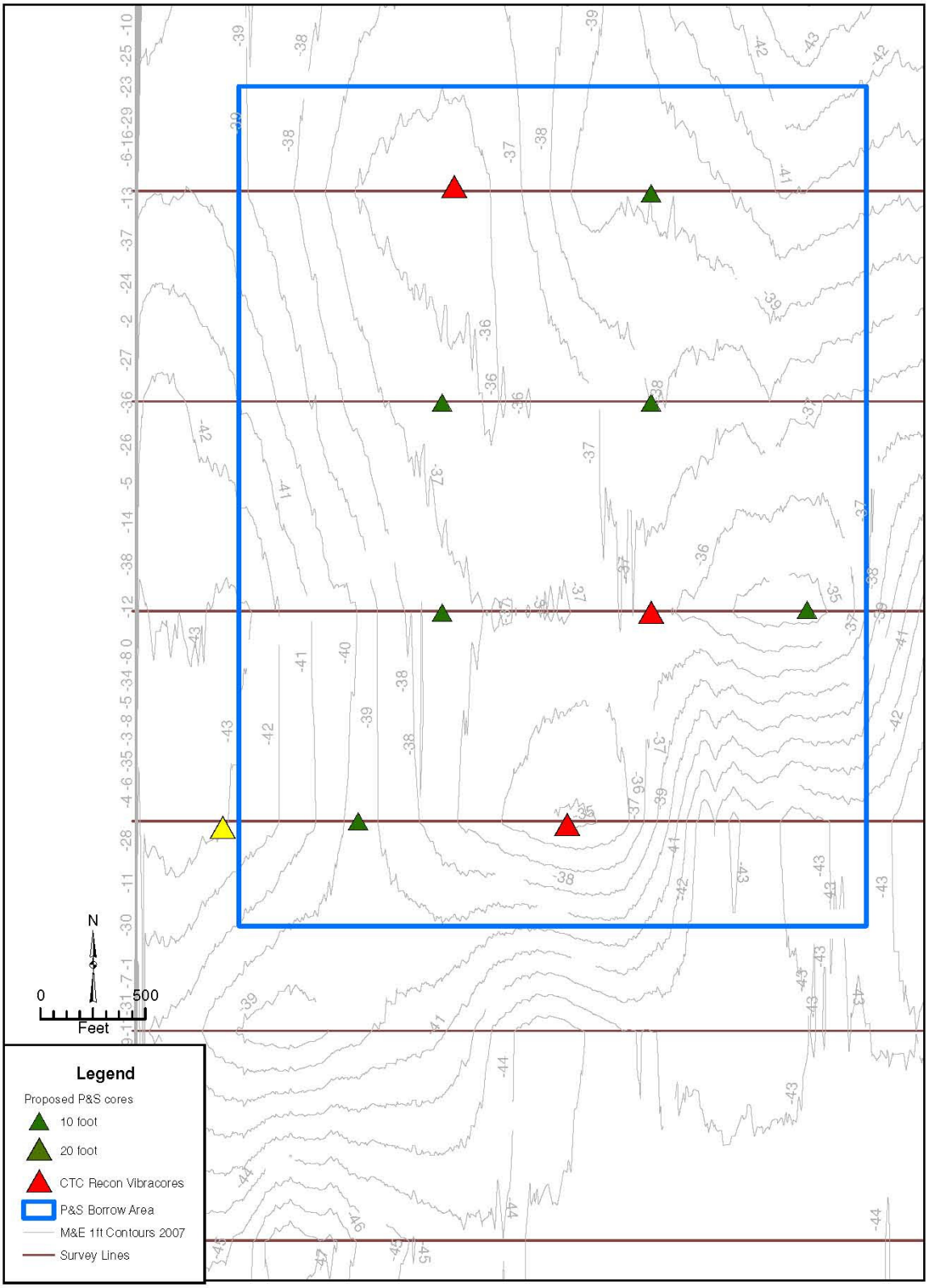


**Figure 6.5: Proposed Plans and Specs Vibracoring Plan: Area D**

## 7.0 References


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